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SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT DEVIL'S SWAMP, LOUISIANA

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLES

FIGURES

INTRODUCTION

This report summarizes the results of a ecological Sreening-Level Risk Assessment (SLRA) for the Devil's Swamp site in Louisiana. The purpose of this report is to evaluate if adequate information exits to determine whether contaminants in Devil's Swamp and Bayou Baton Rouge have little or no adverse ecological effects. This SLRA is intended only as a preliminary evaluation of the potential threats to ecological receptors posed by contaminant concentrations in sediments, biota, and surface waters in Devil's Swamp. The SLRA was performed following methods proposed by the Environmental Protection Agency (EPA) ecological risk assessor, Dr. David Charters (personal comm.).

To minimize the chance of Type II error (the likelihood that the actual risk is greater than that predicted), this assessment is biased toward overestimating risk. If an ecological threat is indicated based on the preliminary site information and calculations in this SLRA, then a detailed problem formulation phase will become necessary to develop a comprehensive risk assessment. Figure I illustrates how the SLRA fits into the risk assessment process for this site.

The EPA *Framework for Ecological Risk Assessment* (USEPA 1992) describes the basic structure and principles for scientifically evaluating the adverse effects of stressors on the environment. This SLRA follows the *Framework* paradigm and is presented in five major sections.

Section 1 comprises the Preliminary Problem Formulation phase. Specific objectives of this first phase are to:

- Provide an overview discussion and brief historical background of the site;
- Describe the environmental setting, including known or suspected contaminants;
- Describe the major contaminant fate and any transport mechanisms that may exist;
- Evaluate general ecotoxicity mechanisms and potential ecological receptors; and
- Develop exposure pathways of concern.

Section 2 provides a preliminary ecological effects evaluation. Two basic objectives of this section are to:

- Evaluate ecological effects associated with the contaminants documented in Devil's Swamp; and
- Develop screening ecotoxicity values for the contaminants.

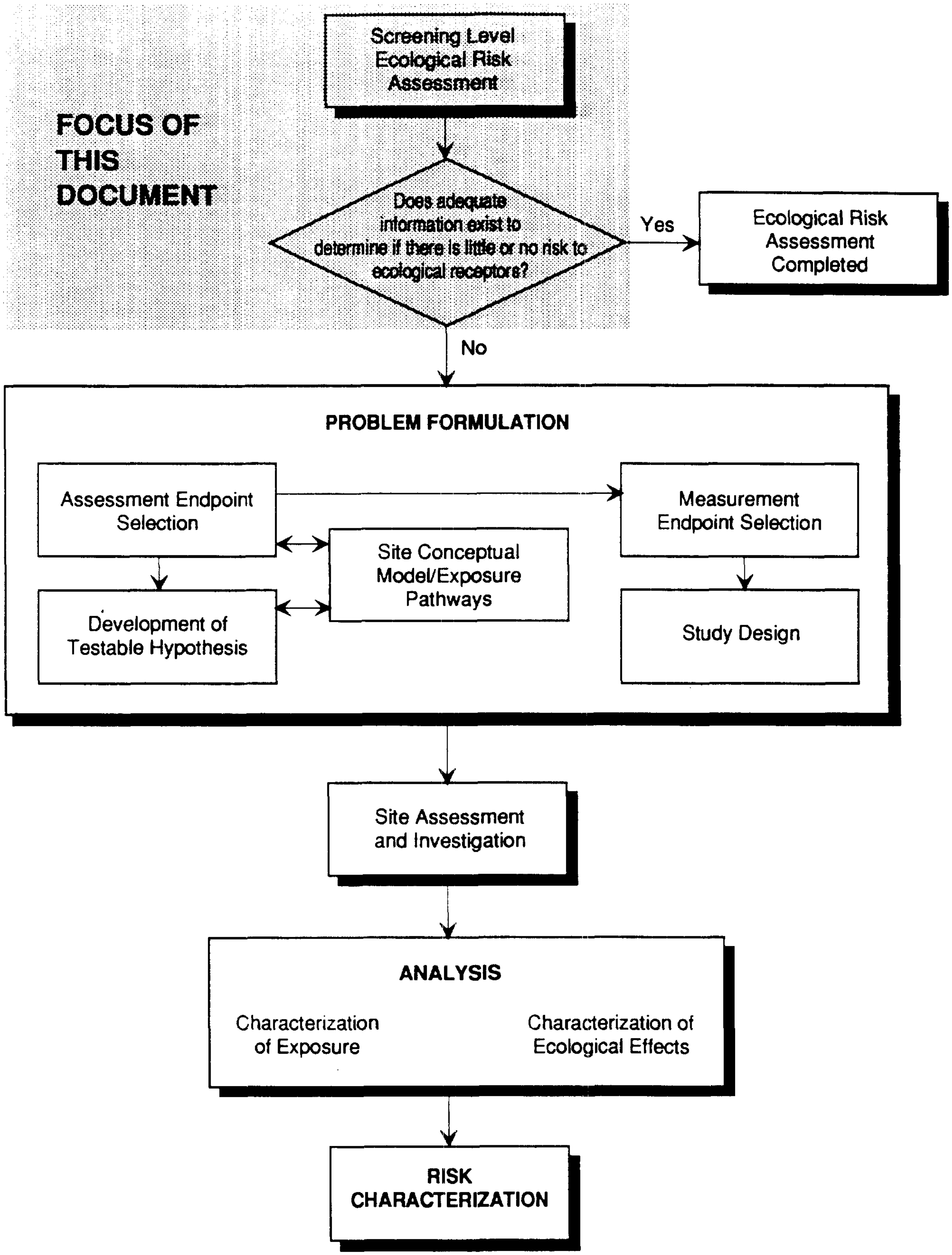


Figure I
Ecological Risk Assessment Process
Devil's Swamp

Section 3 presents a preliminary exposure estimate which includes the development of a screening model to quantify potential exposures to selected receptor organisms.

Section 4 provides preliminary risk calculations. Quantitative screening risk values are calculated using the exposure estimates from Section 3 and the screening ecotoxicity values developed in Section 2. The major uncertainties involved in the calculation of risks to the modeled receptors are also discussed.

Section 5 is a summary of the initial characterization of potential risks to ecological receptors in Devil's Swamp.

1.0 PRELIMINARY PROBLEM FORMULATION

1.1 Site Overview

The study site encompasses the Devil's Swamp flood plain and portions of Bayou Baton Rouge. The site is approximately 3 kilometers (km) north of the city Baton Rouge in East Baton Rouge Parish, Louisiana. The Devil's Swamp flood plain is a freshwater wetlands covering about 18 square km of land along the Mississippi River (Figure 1-1). Northern Devil's Swamp has an elevation of approximately 10.5 meters (m) above mean sea level (MSL) and is bordered on the west by the natural levee of the Mississippi River, and on the east by a Pleistocene terrace at an elevation approximately 12 m above the swamp.

In general, surface water from Bayou Baton Rouge flows through the terrace from the north and forms various distributary channels in Devil's Swamp, which eventually re-emerge into Southern Bayou Baton Rouge and into the Mississippi River. When the Mississippi River is below flood stage, the surface water in northern Devil's Swamp flows into Devil's Swamp Lake and to southern Bayou Baton Rouge. However, some of the bayou's distributary channels flow northwest to Brooks Lake. When the Mississippi River is at or above flood stage, the direction of surface water flow may reverse.

Southern Devil's Swamp is bordered to the east and west by the levee of the Baton Rouge Harbor and the natural levee of the Mississippi River, respectively. When the Mississippi River is below flood stage, the surface water in southern Devil's Swamp flows to the southwest from Devil's Swamp Lake into southern Bayou Baton Rouge. Surface water flow from Thomas Point appears to flow to southern Bayou Baton Rouge and south into the Mississippi River. When the Mississippi River is at or above flood stage, the direction of surface water flow in this area may also reverse. Southern Devil's Swamp is about 9 m above MSL.

Prior to the 1950's, the area surrounding Devil's Swamp consisted of scattered agricultural farms, pasture land and some timber. Rapid industrialization throughout the 1960's and 1970's resulted in numerous waste storage sites and releases of hazardous substances in areas surrounding Devil's Swamp. These sites were used as depositories for various organic wastes from petrochemical processes and refining industries, landfills, and receiving basins. Sites such as the Petro Processor of Louisiana, Inc. (PPI) Scenic and Brooklawn disposal sites are now on the Superfund National Priorities List (NPL). Historic activities associated with these sites resulted in the contamination of shallow soils and groundwater.

The PPI Scenic disposal site is about 3 hectares and located on the west side of U.S. Highway 61, along the east bank of Bayou Baton Rouge. The 22-hectare PPI Brooklawn site is located on Brooklawn Drive about 3 km west of the intersection of U.S. Highway 61 and Brooklawn Drive. Various solid, semi-solid, and liquid industrial wastes were disposed of at Scenic and chlorinated organic wastes were deposited at Brooklawn. At both sites, unlined pits were used. Contaminated sediments have been identified in Bayou Baton Rouge and its various distributary

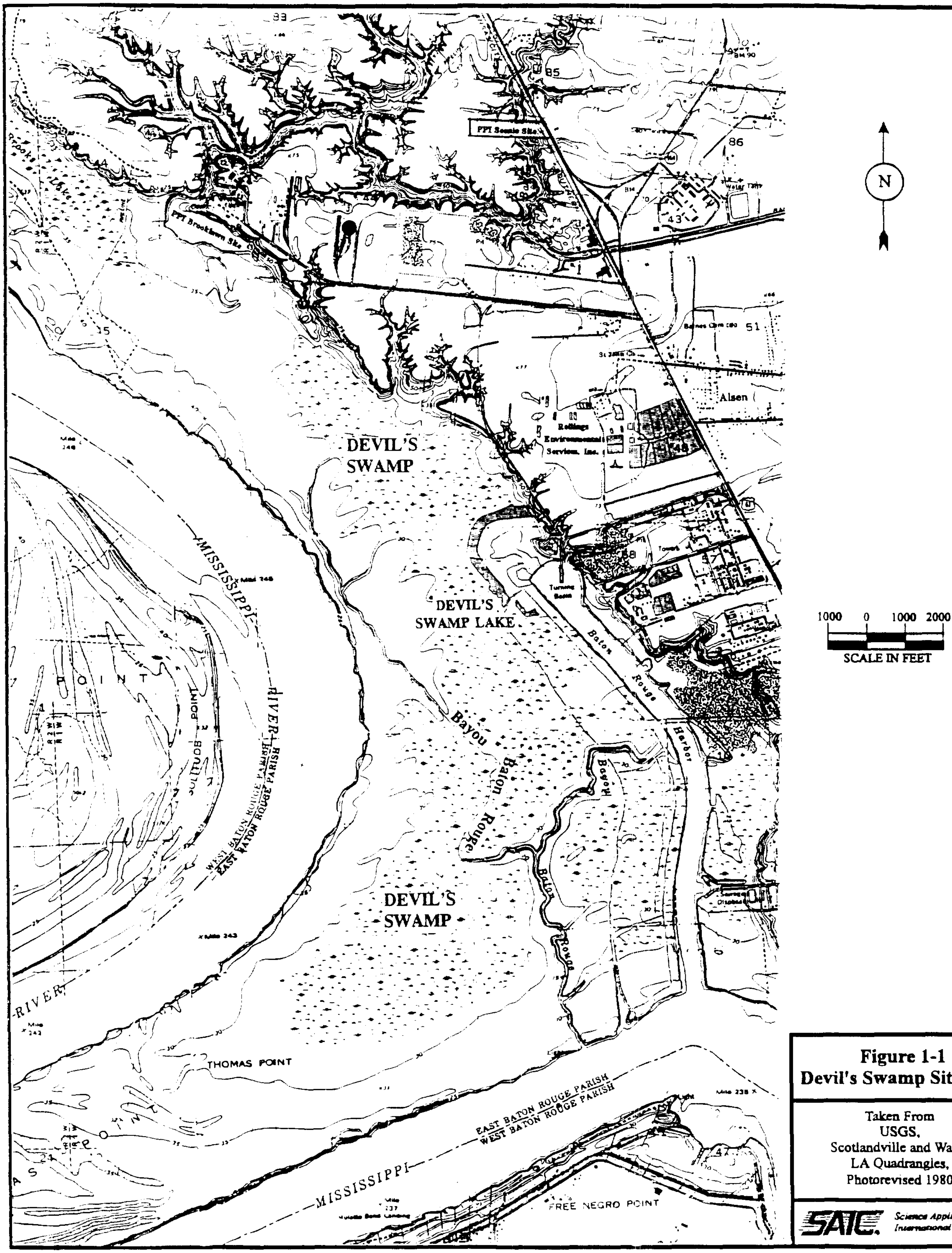


Figure 1-1
Devil's Swamp Site Map

Taken From
USGS,
Scotlandville and Walls,
LA Quadrangles,
Photorevised 1980

SAIC Science Applications International Corporation channels extending into Northern Devil's Swamp. Contaminants associated with these sites include chlorinated hydrocarbons and metals (PRC 1993a).

Rollins Environmental Services of Louisiana, Inc. (Rollins) is located north of the Baton Rouge Barge Harbor and west of U.S. Highway 61. Rollins has been operating a hazardous chemical disposal facility since 1971. Most of the landfill cells and receiving basins were below grade and used the natural clay soils for liners. In 1980 Rollins initiated improvements to the facility which included excavation of previous disposal units, the construction of new landfills with liners (clay and synthetic), and implementation of a groundwater monitoring and recovery program. Rollins has a National Pollution Discharge Elimination System (NPDES) permit allowing treated waste water and storm water to be discharged through two outfalls. The treated wastewater is discharged directly to the Mississippi River via a pipeline and storm water runoff is discharged via the Rollins outfall ditch (PRC 1993a). Currently, Rollins is permitted under the Resource Conservation and Recovery Act (RCRA) and the Hazardous and Solid Waste Amendments.

Other industrial facilities within the vicinity of Devil's Swamp include:

- Schuylkill Metal Corporation - A resource recovery facility that recycles spent lead batteries and other inorganic lead-bearing materials. Elevated concentrations of cadmium, lead and other heavy metals have been detected in sediments downstream of the facility.

- Reynolds Metals - Operates a calcined coke facility north of the PPI Brooklawn disposal site.

- Union Tank Car - An inactive railroad tank car repair and inspection facility with waste water treatment ponds. Several incidences of unidentified spills were noted (LDNR 1981).

- Kaiser Aluminum - The fenced land has been used for the stockpile of bauxite (an aluminum ore).

- Grant Chemical Division of Ferro Corporation - An active facility that manufactures and blends various organic and inorganic chemicals. Several releases of hazardous materials have been recorded as well as effluent discharges to Bayou Baton Rouge.

Investigations conducted by the EPA Field Investigation Team in 1985 and by the state of Louisiana Department of Environmental Quality (LDEQ) in 1986, revealed chlorinated hydrocarbons including hexachlorobenzene (HCB) and hexachlorobutadiene (HCBD); and metals contamination of soil, surface water, and sediments in Devil's Swamp; and polychlorinated biphenyls (PCBs) in Devil's Swamp Lake. In 1987, LDEQ investigations confirmed the presence of HCB, HCBD, and PCBs in edible portions of fish tissue collected from Devil's Swamp Lake.

1.2 Environmental Setting and Site Contaminants

1.2.1 Environmental Setting

Because of limited site-specific information, descriptions in this section are based primarily on published literature for wetlands in southern Louisiana which may represent conditions similar to Bayou Baton Rouge and Devil's Swamp.

Bayou Baton Rouge flows northeast to southwest, intersects Baker Canal, and enters the northern part of Devil's Swamp near the PPI Brooklawn site with an average annual flow rate of 0.70 cfs (LDEQ 1993). Before reaching Haul-Buck Marine Road, the main bayou channel divides into numerous distributary channels. These channels are interconnected and flow into a large area of ponds, sloughs, and freshwater wetlands (Devil's Swamp). At the southern part of Devil's Swamp, distinct channels reappear and the swamp drains slowly into the Mississippi River.

Devil's Swamp consists of undeveloped forested wetlands within the floodplain of the Mississippi River. Backwater and overbank flooding from the River occurs during late winter through spring. Low river stages typically occur during autumn. These seasonal stages also affect the shallow ground water in the alluvial floodplain deposits and the terrace deposits (ENCOTEC 1992). The flooded backwaters serve as an important feeding and nursery area for main channel fishes.

These seasonal flooding conditions affect several physical and chemical properties such as water level, flow rate of surface water, dissolved oxygen, turbidity, and pH. Flooding events can also influence nutrient loading as well as transport of sediment and other organisms to different sites within a specific area of the swamp. This in turn affects the composition of communities, the abundance of species, and the interactions between species. For example, pelagic fish occupy more backwater areas during high water levels than during low water levels. This shift may in turn affect species which prey on fish. During seasonal dry events, stagnation within the swamp occurs and small communities may become isolated.

Complex biological, physical, and chemical interactions are found within and at the hydrologic boundaries between habitat types within the study area. Such interactions include flow of nutrients and energy; biomass transformations and degradation of flora and fauna; spatial and temporal transport and deposition of organic matter and other chemicals; and partitioning of resources by competing plants and animals. These interactions and other changes in environmental conditions (e.g., disturbances from human activity and the weather) largely determine the composition of the biota, soils, and water of the swamp.

For the purposes of this SLRA, the primary habitats of concern are generalized into three categories: 1) Cypress and mixed swamp forest; 2) riverine; and 3) open-water. These habitats provide for diverse communities of plants and animals. Within each habitat there are species which may be more susceptible to contamination due to their foraging or hunting practices or overall behavior. Representative plant and animal species associated with the three major habitats of Devil's Swamp and Bayou Baton Rouge are presented in Tables 1-1 and 1-2. Each habitat type is briefly discussed below.

Cypress and mixed swamp forest

The distribution of cypress and mixed swamp communities is largely determined by topography and surficial sediments. These factors control hydrology and soil composition of the swamp, which have direct effects on the types of communities. The mixed swamp forest habitat is generally characterized as semi-permanently flooded areas with water depths less than 2 meters. The dominant vegetative cover may be either forested, emergent, or open. Bald cypress, water tupelo, and red swamp maple are tree dominants. The understory within these swamps is composed of a wide variety of vines, ferns, aquatic plants, and saplings of overstory species. Peppervine, green briar, alligator weed, and swamp lily are plants inhabitating the wetter portions of Devil's Swamp. A variety of insectivorous plants, such as pitcher plants, trumpets, and sundews add to the diversity of vegetation. Alligators may be seen pursuing gars or an occasional cottonmouth snake may be observed. Various waterfowl would be in pursuit of small fish, crawfish, frogs, and aquatic insects. Nutria, muskrat, and mink are among the other primary consumers.

Riverine

The riverine habitat is represented by northern Bayou Baton Rouge before it drains into Devil's Swamp and the southern Bayou Baton Rouge drainage flowing into the Mississippi River. The vegetative community associated with the banks of the Bayou include willows, pumpkin ash, and rushes. Along the edges of this riverine habitat,water lillies and submerged aquatic plants provide cover for river otter which may feed on bullfrogs and salamanders. Many freshwater fish in the riverine system are directly connected to the wetlands. Several species require areas of shallow water for breeding and feeding or some other part of their life cycle. The nutrient-rich waters of the riverine ecosystem strongly influence fish communities in the backwater areas of the swamp, especially on a seasonal basis.

Open water habitat

Open water habitat includes the ponded water which exceeds 2 meters in depth and lacks persistent emergent vegetation. Devil's Swamp Lake and numerous small ponds throughout the swamp are considered in this habitat type. The typical flooded areas are a mosaic of emergents, submergents, and floating plants. Algae, including phytoplankton, also contribute to the base of the food chain. Narrow- and broad-leaved emergents (i.e., cattail and arrowheads, respectively) are found along the water edges. Floaters, such as the water lillies, duckweed, and water lettuce are most often found in the quiet waters. Submergents, like the bladderworts,

Table 1-1
Representative Plant Species Within Devil's Swamp and Bayou Baton Rouge

Trees & Shrubs	Understory Plants	Aquatic Plants
Red Swamp Maple *Acer rubrumva*	Peppervine *Ampelopsis arborea*	Alligator weed *Alternanthera philoxeroides*
Water Tupelo *Nyssa sp.*	Dewberry *Rubus sp.*	Water fern *Azolla caroliniana*
Bald Cypress *Taxodium distichum*	Swamp Lily *Crinum americanus*	Water lettuce *Pistia statiotes*
Pumpkin Ash *Fraxinus tormentosa*	Trumpet Creeper *Campsis radicans*	Water Hyacinth *Eichhornia crassipes*
Box Elder *Acer negundo*	Red Vine *Bunnichia cirrhose*	Water Lilly *Nymphaea odorata*
Green Ash *Fraxinus pennsylvanica*	Grape Vine *Vitis sp.*	Rushes *Juncus sp.*
Water Locust *Gleditsia aquatica*	Redweed *Amaranthus retroflexus*	Water Shield *Brasenia schreberi*
Sycamore *Platanus occidentalis*	Morning Glory *Jaquemontica tumnifolia*	Duckweed *Lemna minor*
Hackberry *Celtis laevigata*	Yellow Flag *Iris pseudacorus*	Water Pennywort *Hydrocotyle ranunculoides*
Waxmyrtle *Myrica cerifera*	Green Briar *Smilax sp.*	Cattail *Typha sp.*
Sweet Pecan *Carya pecan*	Arrowheads *Sagittaria sp.*	Lizard's Tail *Carex sp.*
Swamp Privet *Foresteria acuminata*	Wild Ageratum *Eupatorium coelestinum*	
Buttonwillow *Cephalanthus occidentalis*	Rattan *Berchemia scandens*	
Water Elm *Planera aquatica*	Rose-mallow *Hibuscus sp.*	
Cottonwood *Populus deltoides*	Wild Millet *Echinochola sp.*	
Black Willow *Salix nigra*	Poison Ivy *Toxicodendron radicans*	
	Cocklebur *Xanthium stramatium*	

Table 1-2
Representative Animals Within Devil's Swamp and Bayou Baton Rouge

Mammals *(Order)*	Reptiles & Amphibians *(Order)*	Birds *(Family)*	Fish *(Family)*	Invertebrates *(Order)*
Nutria *Myosaster coypus*	Alligator *Alligator Mississippiensis*	Great Blue Heron *Ardes herodias*	Gars *(Lepisosteidae)*	Hydras *Class Hydrozoa*
Opossum *Didelphis virginiana*	Bull Frog *Rana catesbiana*	Wood Duck *Aix sponsa*	Catfish and Bullheads *(Ictluridae)*	Flatworms *Class Turbelleria*
Nearctic River Otter *Lutra canadensis*	Green Treefrog *Hylka cinera*	Mallard *Anas platyrhynchos*	Buffalos and Suckers *(Catostomidae)*	Earthworms *Class Oligochaeta*
Mink *Mustela vison*	Other Frogs and Toads *(Anura)*	Double Crested Coromorant *Phalacrocorax auritus*	Pickerel *(Ecocidae)*	Snails *Class Gastropoda*
Swamp Rabbit *Sylvilagus aquaticus*	Cottonmouth *Aakkistrodon piscivoros*	Common Egret *Casmerodius albus*	Herring and Shad *(Clupeidae)*	Aquatic sow bugs *(Isopoda)*
Raccoon *Procyon lotor*	Snakes and Lizards *(Squamata)*	Limpkin *Aramus guarauna*	Bass *Microptous sp.*	Amphipods *(Amphipoda)*
Squirrel *Sciurus sp.*	Softshell turtle *Apalone mutica*	Common Grackle *Quiscalus quiscula*	Sunfish *Lepomis sp.*	Crawfish and shrimp *(Decapoda)*
Bats *(Chiroptera)*	Other Turtles *(Testudines)*	Common Crow *Corvus brachyrhychos*	Topminnows *(Cyprinodontidae)*	Waterfleas *(Diplostraca)*
Least shrew *(Insectivora)*	Salamanders *(Caudata)*	Blue Jay *Cyanocitta cristata*	Freshwater drum *Aplodinotus grunniens*	Mayflies *(Ephemeroptera)*
Voles, mice, rats *(Rodentia)*		Wild Turkey *Melagris gallopavo*	Crappies *Pomoxis sp.*	Midges & Mosquitos *(Diptera)*
Whitetailed Deer *Odocoileus virginianus*		Warblers & Blackbirds *(Emberizidae)*	Chubs and Shiners *(Cyprinidae)*	Dragonflies and Damselflies *(Odonata)*
		Hawks & Eagles *(Accipitridae)*	Darters *(Percidae)*	Caddisflies *(Trichoptera)*
		White Ibis *(Eudocimus albus)*	Bowfin *Amia calva*	Beetles *(Coleoptera)*
		Woodpeckers *(Picidae)*		Spiders & Mites *(Araneae and Acariformes)*

milfoils, and pondweeds, may also be found in this habitat type. A mixture of waterfowl and other birds utilize the more open water areas to feed on the aquatic vegetation and fish.

At higher, drier elevations, the vegetation and animals change in response to the degree of flooding. Cypress and tupelos are replaced by hardwoods such as the black willow and water locust. In addition, sedges, ferns, and wildflowers increase in abundance along with rodents, swamp rabbits, and raccoons.

The threatened or endangered animal species that have been identified in the area include: 1) the peregrine falcon (*Falco peregrinus anatum*), 2) bald eagle (*Haliaeetus leucocephalus*), and 3) pallid sturgeon (*Scaphirhyncus albus*). The peregrine falcon and bald eagle overwinter in the area, and the pallid sturgeon inhabits the Mississippi River near the mouth of Bayou Baton Rouge. The only plant species on the federal threatened or endangered list is the square-stemmed monkey flower (*Mimulus ringens*). This plant is known to occur on the river sides of the Mississippi River levees near Baton Rouge (LDWF 1993).

1.2.2 Contaminants in Devil's Swamp/Bayou Baton Rouge

Subsequent to the investigations by EPA and LDEQ in 1985 through 1987 in Devil's Swamp and Devil's Swamp Lake, additional investigations have also detected chemical contaminants in the sediments and surface water within the site area. A number of organic compounds and trace elements were reported in sediment, surface water, and/or tissue samples from Devil's Swamp. Data used for this screening level risk assessment were obtained from the following sources:

- Site inspection of Bayou Baton Rouge (PRC 1993a),
- Expanded site inspection of Devil's Swamp (PRC 1993b),
- Expanded site inspection of Devil's Swamp Lake (PRC 1993c),
- NPC Services, Inc. toxicity study results for biota (LDEQ 1993).

Northern Bayou Baton Rouge

Three surface water and 22 sediment samples were collected in Bayou Baton Rouge during a site inspection (PRC 1993a) in October 1992. Most of these samples (19) were located in the vicinity of the Scenic disposal site; and the remainder were focused near the Schuylkill metals facility. The highest concentrations of organic contaminants detected in the sediments near the Scenic site were HCB (49.0 mg/kg) and HCBD (65.0 mg/kg). These two contaminants were not detected in related surface water samples. Other volatile organic compounds (VOCs) such as 1,2-dichloropropane, 1,1,2-trichloroethane, and vinyl chloride were detected in both sediments and surface water in this area.

Near the Schuylkill metals facility, elevated concentrations of inorganic chemicals such as arsenic (618 mg/kg), cadmium (8.1 mg/kg), lead (1,410 mg/kg), and zinc (1,820 mg/kg) were found in the sediments. In the surface water sample, cadmium, lead, mercury, and zinc were detected.

Devil's Swamp

In October 1992, 36 sediment samples and 4 surface water samples were collected as part of the expanded site inspection of Devil's Swamp and southern Bayou Baton Rouge (PRC 1993b). The samples were distributed throughout the swamp. Due to the large area of Devil's Swamp, data were summarized by geographical area. The northern portion of Devil's Swamp (within approximately 3,000 feet of the PPI Brooklawn site) was represented by 11 sediment samples. Chlorobenzenes and VOCs were the predominant contaminants in the sediments. Among the numerous contaminants detected, the concentrations of HCB ranged from 6.4 to 120 mg/kg, HCBD ranged from 4.8 to 12,000 mg/kg, and tetrachloroethene ranged from 0.016 to 220 mg/kg. Other contaminants in the sediments included various polycyclic aromatic hydrocarbons (PAHs). The surface water sample from this northern area contained HCBD (0.074 mg/L), 1,2-dichloroethene (0.025 mg/L), and mercury at 0.025 mg/L.

NPC Services, Inc. (NPC) collected and performed selected chemical analyses on sediment, surface water, and biota samples (fish, mollusks, ducks, and raccoons) from about 30 locations in the northern portion of the swamp. Concentrations of HCB and HCBD were detected in each of the biota samples.

In the sediments of the central Devil's Swamp area including Devil's Swamp Lake, PCBs, PAHs, cadmium, and lead were the primary contaminants detected. Several pesticides were also detected. There were no detections of chlorinated organics in surface water samples.

In southern Devil's Swamp sediments, PCBs, acetone, phenanthrene, and lead were the main contaminants detected. No surface water samples were collected from southern Devil's Swamp.

Analytical data from 18 sediment/soil samples taken along a proposed pipeline route (PRC 1994) revealed detectable levels (generally less than 0.1 mg/kg) of tetrachloroethene, PCBs, and various polyaromatic hydrocarbons. Organic chemicals were not detected in any of the 18 surface water samples. Copper and lead were detected in the water samples at concentrations less than 0.005 mg/L. Mercury was detected at low concentrations (0.0002 mg/kg and 0.0002 mg/L) in both the sediments and surface water, respectively.

Southern Bayou Baton Rouge

From six sediment samples collected in southern Bayou Baton Rouge, acetone, PCBs, cadmium, and chromium were detected. No contaminants were detected in one surface water sample.

Tables 1-3 and 1-4 summarize the number and types of samples collected in each medium and used in this SLRA. Summary statistics of the chemical contaminants detected in each medium are presented in Appendix A.

The available data suggest a generalized pattern of contamination within the vicinity and downstream of the Scenic and Brooklawn sites. However, the contaminant mix varies geographically, particularly with respect to chlorinated hydrocarbons, metals, and PCBs. The spatial distribution of contaminants is primarily a reflection of biased sample locations that were selected in the field in favor of locating potential hot spots. Thus the extent of contamination, particularly within the biological medium, is largely unknown.

1.3 Contaminant Fate and Transport Mechanisms

An examination of the fate and transport of classes of chemical compounds which influence contaminant distribution in the environment, provides a foundation for predicting potential exposure pathways for both aquatic and terrestrial organisms.

From a review of the available data (PRC 1993a,b,c; LDEQ 1993), it appears that the primary release mechanisms of contaminants to Bayou Baton Rouge and Devil's Swamp is via contaminated ground water migrating into surface water and sediments, and from waste runoff or infiltration from the sites into water and sediments. The magnitude and extent of contamination in Devil's Swamp is not well known and contaminants are assumed to be released continually from waste disposal sites into the study area. Most of the data currently available were collected from the northern portion of the Swamp and generally less than 3,000 feet south of the Brooklawn site.

Characteristics of the Devil's Swamp wetland ecosystem influence the potential for migration and uptake by aquatic or terrestrial organisms. The swamp is a wetland vegetated by woody plants, trees and shrubs. Wetlands contain soils that are saturated or nearly saturated with water, have a high organic content and are interspersed with areas of shallow standing water. The high organic content in Devil's Swamp will strongly influence chemical bioavailability (Brezovik et al 1991). Wetlands usually have lower levels of oxygen, since the high level of organic matter encourages microbial activity and decomposition of organic matter resulting in rapid oxygen consumption. Soil that is saturated with water allows only slow movement of oxygen. Wetland sediments are similar to river bottom sediments except that they are usually heavily vegetated, can be in contact with the atmosphere, and are often subjected to oxidation-reduction reactions. Anaerobic microbial processes can occur which facilitate the remobilization of chemicals (Hemmond 1994).

Devil's Swamp represents one of the few natural flood plain areas left on the Mississippi River before the river flows into the delta. Seasonal flooding of the swamp area is known to be an important factor in the life cycles of many of the organisms which breed in the swamp due to the large influx of important nutrients. Little information is available on the mobility of contaminants during these flood events or during dry periods.

Table 1-3
Summary of Chemicals Detected in
Sediments and Surface Water Samples in Devil's Swamp/Bayou Baton Rouge

Hazardous Chemical Group	No. of Chemicals Analyzed per Group	No. of Chemicals Detected in Sediment	No. of Chemicals Detected in Surface Water
Volatile Organic Compounds (VOCs)	33	19	15
Chlorinated Benzenes	6	6	0
Polycyclic Aromatic Hydrocarbons (PAHs)	17	15	2
Phenolics	14	2	0
Phthalate Esters	5	5	2
Other Semi-volatile Organic Compounds (OSVOCs)	22	5	2
Polychlorinated Biphenyls (PCBs)	7	3	0
Pesticides	21	18	3
Metals	22	19	13
TOTALS	148	92	37

Sources: PRC (1993a,b,c)

Table 1-4
Summary of Chemicals Detected In Biota in Devil's Swamp

Number of Chemicals Detected in Biota								
Hazardous Chemical Group	No. of Chemicals Analyzed per Group	Pelagic Fish Whole	Pelagic Fish Fillet	Benthic Fish Fillet	Benthic Fish Whole	Duck	Racoon	Mollusk
VOCs	0	--	--	--	--	--	--	--
Chlorinated Benzenes	5	1	1	1	1	1	1	1
PAHs	0	--	--	--	--	--	--	--
Phenolics	0	--	--	--	--	--	--	--
Phthalate Esters	0	--	--	--	--	--	--	--
OSVOCs	4	1	1	1	1	1	1	1
PCBs	0	--	--	--	--	--	--	--
Pesticides	0	--	--	--	--	--	--	--
Metals	13	5	6	5	4	3	4	8
TOTALS	22	7	8	7	6	5	6	10

-- Data not available.

Source: LDEQ (1993)

The fate of contaminants in Devil's Swamp and it environs is determined by the environmental conditions at the site and the properties of the chemicals that influence partitioning and reactions in environmental media. Partitioning between air, soil/sediments, water, and biota depends on their physical and chemical properties. Partitioning of chemicals in the environment has a significant bearing on the potential for biota exposure to contaminants and influences the toxicity of a chemical. It has been shown to be the dominant process governing bioconcentration of trace organics in algae, fish and invertebrates (Rand 1985). Partitioning between sediment and sediment pore water will influence uptake into sediment-dwelling biota, especially those that are detritus feeders. Where the ecosystem food web is benthic-based, persistent lipophilic chemicals will biomagnify in the food web.

Partitioning within aquatic systems (e.g., sediment/water; organic carbon/water, acid volatile sulfides; humic/fulvic acid and water) along with other physicochemical properties help to evaluate the potential fate and transport of chemicals in environmental media. Biological processes (e.g., uptake, bioconcentration, and biotransformation) also occur between the aquatic phase and biota, including microalgae, higher plants, invertebrates and fish; or between sediment and sediment-dwelling biota.

Physicochemical properties of chemicals help to evaluate their fate in the environment, and the potential for exposure to ecological receptors. Important physicochemical properties with regard to fate and transport processes are described below:

- Water solubility is a measure of the maximum capacity of a chemical to be dissolved in the aqueous phase. Chemicals with low solubility (less than 100 mg/L) tend to partition to soil or sediments and bioconcentrate in aquatic organisms.

- Log octanol-water partition coefficient (Log K_{ow}) is a direct estimate of the tendency of a chemical to partition from water to lipids and other organic media. Organic chemicals with a high log K_{ow} (usually greater than 5) are more likely to biomagnify in the food chain. Similarly, the organic carbon partition coefficient (K_{oc}) represents the degree to which chemicals partition to soil or sediments. Chemicals with a high K_{oc} are more likely to partition to sediments.

- Henry's Law Constant is a measure of the solubility of gases in water. It provides a means of estimating the partitioning between water and air, and is an indication of the importance of volatilization from water. Chemicals with a higher Henry's Law Constant will volatilize more rapidly.

- Soil half-life is a measure of the rate of aerobic microbial degradation of organic chemicals within soil. A high soil half-life indicates that microbial degradation is very slow. Biodegradation under anaerobic conditions is generally a slower process than aerobic degradation.

Physical parameters which influence abiotic degradation, including photolysis and oxidation, are not presented here although they may provide additional information about chemical fate. They are not, however, the most critical parameters for understanding the potential for bioconcentration and exposure to chemicals through the food web.

The bioconcentration factor is the concentration of the chemical in an organism equilibrium, divided by the concentration of the chemical in water. It reflects net accumulation after uptake and elimination. For organic compounds, uptake into aquatic organisms is correlated with aquatic concentrations. It has been argued that laboratory BCFs, based on exposure to water concentrations, may underestimate fish residues. This is in part because the uptake rate via the gills at low water concentrations is small relative to the uptake from ingestion (Oliver and Niimi 1985). Where pore water or sediment contamination is of primary concern, bioaccumulation factors (BAFs) are often used. Exposure via ingestion of food is more important for larger molecules that cannot be transported across gill membranes. It is also generally accepted that uptake via food rather than water is the dominant exposure route for compounds with a Log K_{ow} greater than 5 (Neilson 1994).

Table 1-5 represents a compilation of these properties for specific organic chemicals. Metals are not included in this table as the environmental fate and transport of metals are not as well correlated with those of organic chemicals. Metals are instead addressed in Section 1.3.5 below.

The following discussion describes the general fate and transport characteristics of the major contaminant groups found in Bayou Baton Rouge and Devil's Swamp. Some chemicals, for example PCBs, are treated as a separate category of compound. There were 92 contaminants detected in the study area, however only a few selected contaminants in each group are specifically discussed with respect to their potential environmental fate. These selected contaminants were generally detected at higher concentrations and/or frequencies.

1.3.1 Chlorinated Hydrocarbons

Chlorinated hydrocarbons represent one of the more persistent class of compounds once released into the environment, especially those compounds that are extremely hydrophobic. Many of these compounds bioaccumulate in aquatic organisms and some will biomagnify in the food chain. They are known to occur widely in the aquatic environment. Those volatile chlorinated hydrocarbons which are of smaller molecular weights and are less hydrophobic, for example, tetrachloroethene, exhibit somewhat different environmental fate and transport mechanisms. They tend to volatilize more rapidly into air and have lower organic carbon partition coefficients, exhibiting high leaching potentials through soils to groundwater. They will preferentially partition out of the water column but less so than those chlorinated hydrocarbons which are more hydrophobic and, therefore, also have lower bioconcentration factors.

<u>Hexachlorobenzene (HCB)</u> - HCB is an environmentally persistent chemical due to its chemical stability and resistance to biodegradation. Because HCB has a high K_{ow} and high K_{oc}, it is strongly sorbed to sediments and is generally not susceptible to leaching from soils. Adsorption

Table 1-5
Physicochemical Properties of Selected Organic Chemicals

Chemical Compound	Molecular Weight (g/mole)	Water Solubility (mg/L)	Log Octanol/Water Partition Coefficient (Log K_{ow})	Organic Carbon Partition Coefficient (K_{oc}) (ml/g)	Fish Bioconcentration Factor (Log BCF) (L/kg)	Henry's Law Constant (atm-m^3/mole)	Aerobic Biodegradation Soil Half-Life (Days)
Hexachlorobutadiene	260.8	2-2.6	4.78	4.7E+3	4.06[a]	0.001-0.026	119
Hexachlorobenzene	284.8	.0062	6.18	1.2E+6	4.5[b]	6.8E-4	1,530
Tetrachloroethene	166	150	2.60	3.64E+2	1.69[d]	2.59E-2	270
PCBs (Aroclor mixtures)	192-375.7	0.027-0.59	4.7-6.8	4.54E+4	4.85-5.0[c]	2.9E-4 - 4.6E-3	no significant degradation
Phenanthrene	178.2	1.15	4.46	1.88E+4	3.42[c]	2.33E-5	108
N-nitrosodiphenylamine	198.2	35.1	3.13	1.2E+3	2.34[a]	5.0E-6	22
DDT	354.5	0.025	6.36	1.52E+5	4.97[a]	8.1E-6	3,212
DDD	320.05	0.09	6.02	1.6E+4	4.90[e]	4.06E-6	3,212
DDE	318.02	0.12	5.69	5.01E+4	4.91[a]	2.1E-5	3,212

NOTES: [a] = rainbow trout [b] = largemouth bass [c] = fathead minnow [d] = bluegill sunfish [e] = mosquito fish
Sources: ENVIROFATE (1995)
ATSDR (1989; 1994a,b)
Howard et al (1991) for biodegradation rates

will increase with the percent carbon in the sediments. Its strong affinity for sediment, lack of significant biodegradation and its strong hydrophobic nature results in bioaccumulation in aquatic organisms. Log BCFs in green algae have been reported at 4.39 and a range of BCFs from 1.9 to 4.5 was reported in fish species, including sheepshead minnow, fathead minnow, mosquito fish, sunfish and largemouth bass (Laseter 1976). Laseter also reported field BCFs of approximately 3 for crawfish in Louisiana under contaminated field conditions. HCB will biomagnify in the food chain. In one study, the concentration of chemical in pore water was the main factor affecting bioconcentration (Howard 1991). Its Henry's law constant indicates that it can volatilize rapidly from the water column; its half-life due to evaporation has been reported at 8 hours.

Hexachlorobutadiene (HCBD) - HCBD is insoluble in water and preferentially partitions out of the water column to sediments and biota (ATSDR 1994b). When released to aquatic environments, HCBD tends to sink to the sediments due to its high specific gravity (Clement Assoc. 1985). It will volatilize rapidly from water, and it will substantially bioaccumulate. HCBD is expected to biomagnify (K_{ow} of 4.78), and its short soil half-life indicates it will biodegrade under aerobic conditions (Howard 1989).

Tetrachloroethene (PCE) - Evaporation of PCE from soil is fairly rapid due to its high vapor pressure and low adsorption to soil. Biodegradation may be an important process in anaerobic soil, however PCE is not expected to biodegrade significantly in soils. In water, PCE is subject to rapid volatilization, and half-lives for evaporation from water have been observed ranging from 3 hours to 14 days. Some bioconcentration will occur in biota, however to a lesser degree than some other chlorinated hydrocarbons. Log BCFs in fish and microorganisms are generally less than 2.5 (Mackay 1992).

1.3.2 Polychlorinated Biphenyls (PCBs)

PCBs - PCBS are closely related to chlorinated hydrocarbon pesticides, such as DDT in chemical and toxicologic properties. There are 209 different PCB compounds, termed congeners, based on possible chlorine substitution patterns. They exhibit a high degree of bioconcentration, biomagnification and persistence in the environment and are thus treated as a special class of compounds. In the United States, mixtures of various PCB congeners were formulated for commercial use under the trade name Aroclor on the basis of their percent chlorine content (e.g., aroclor 1254 has an average chlorine content of 54 percent by weight). PCBs are extremely persistent in the environment and are bioaccumulated throughout the food chain. Recent aquatic environmental studies indicate that many of the most potent, dioxin-like PCB congeners are preferentially accumulated in higher organisms. This preferential accumulation probably results in a significant increase in the total toxic potency of PCB residues as they move up the food chain (USEPA 1989).

PCBs are insoluble in water and will partition out the water column and adsorb strongly to sediments and suspended matter. The solubility of PCBs is shown as a range on Table 1-5; it decreases with increasing chlorination. The organic carbon partition coefficient is higher for the less chlorinated isomers, indicating they will sorb more strongly. Like hexachlorobenzene and hexachlorobutadiene, they will also volatilize rapidly out of water. PCBs of the higher chlorinated biphenyl groups (e.g., higher than the tetrachlorinated biphenyls) do not significantly biodegrade in soils, especially those with high organic carbon content. In sediments there appears to be a potential for anaerobic biodegradation which is determined by congener reactivity. Log BCFs have been reported for many of the PCB isomers (Mackay 1992). Those reported for the aroclor mixtures (aroclor 1248 and 1254) ranged from 4.42 to 5.0 for fish species, including the bluegill sunfish, channel catfish and fathead minnow. A range of BCFs (3.86 to 4.42) for mussels and BCFs for shrimp (4.41) were also reported. Bioconcentration via contaminated food is the principle route of uptake for low water-soluble compounds like PCBs. The major source to plant vegetation is through contact with volatilized PCBs in the air (Hoffman 1995).

1.3.3 Polycyclic Aromatic Hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons are base/neutral organic compounds that have a fused ring structure of two or more benzene rings. They will partition out of the water column and adsorb onto organic and inorganic particulate matter and deposit in bottom sediments. When they are incorporated into anoxic sediments they may persist for long periods of time (Rand 1985). PAHs can accumulate in aquatic organisms from water, sediments, and food. The range of Log BCFs in fish and crustaceans has been reported as 2 to 3.3 and is usually greater for high molecular weight PAHs. Sediment-associated PAHs can be accumulated by bottom-dwelling invertebrates and fish. Bivalves are good bioaccumulators of some PAHs because they do not metabolize these compounds as rapidly as fish. Half-lives for elimination of PAHs in fish ranged from less than 2 days to 9 days (USEPA 1993j). While PAHs are rapidly metabolized, the metabolic by-products are usually toxic to fish.

Phenanthrene - Phenanthrene is considered a low molecular weight PAH. It is insoluble in water and tends to adsorb onto sediments and bioaccumulate in aquatic organisms. Phenanthrene has also been shown to bioconcentrate in microorganisms, algae, and fish. It is not expected that phenanthrene will biomagnify up the food chain.

1.3.4 Pesticides

Organochlorine pesticides, such as DDT and its degradation products DDE and DDD, are not easily metabolized by microorganisms and therefore, persist in the environment. These compounds are either insoluble or have relatively low solubility in water and exhibit high lipid solubility. They bioaccumulate to high concentrations through aquatic food chains to secondary consumers such as fish, piscivorous birds, and mammals including humans. They are biomagnified 30 to 100 fold in tissues and in the eggs of fish-eating birds. Terrestrial organisms experience a ten-fold increase in bioconcentration (Hemmond 1994). Residues of these pesticides may be stored in fat deposits. Several of these pesticides, such as heptachlor and aldrin are rapidly metabolized in organisms, however their metabolites, heptachlor epoxide and dieldrin are persistent and toxic (Hemmond 1994).

DDT, DDE, and DDD - DDT and its degradation products are similar to PCBs in their environmental fate and transport mechanisms. Soil half-lives were reported at 3,212 days. DDT's insolubility in water and high log K_{ow} reflects its lipophilic nature, it exhibits a high degree of bioaccumulation and storage in fatty tissue, which leads to biomagnification in the food chain. Biotransformation may be a significant factor in the distribution of DDT in the environment, however it is degraded to DDD and DDE which are also persistent and biomagnifiable. Avian species and terrestrial mammals that are highly piscivorous in their feeding habits will experience much higher concentrations in their body tissues than lower trophic levels. DDT and its degradation products will significantly sorb to organic matter in sediments.

1.3.5 Other Organic Chemicals

One chemical from the amide group, a nitrosoamine, is discussed in this section. These chemicals are generally more polar and soluble in water than many of the hydrophobic chemicals. In some cases, both ionic and neutral species are subject to dissociation. There is also a tendency for these chemicals to evaporate less, be less sorptive than other chemical contaminants, and bioaccumulate to a lesser degree.

N-nitrosodiphenylamine - N-nitrosodiphenylamine is insoluble in water and has a very low potential for evaporation. It preferentially partitions to sediments and organic matter. It will move out of the water column and bioaccumulate in aquatic organisms. It appears to biodegrade under aerobic conditions, having the shortest soil half-life (22 days) among the chemicals presented here. This factor will influence whether it will persist in the environment.

1.3.6 Metals

The partitioning of metals in soil does not correlate well with total organic carbon content of the soil as it does for organic compounds. The environmental fate of metals is more a function of complexation and cation exchange capacity (CEC) of the soil substrate. Metals form complexes with natural humic and fulvic substances, found in organic-rich sediments, and with the cations that are present in surface water. A high soil CEC will increase sorption of metals to soil particles and may limit the solubility of metals. Solubility of metals in water is principally controlled by pH, type and concentration of complexing ligands, chelating agents and the oxidation/reduction potential of the immediate environment. Knowledge of the determinants of metal bioconcentration is limited, however speciation does play a role in bioavailability. Uncomplexed metal ions are apparently more readily assimilated by organisms than are complexed forms (Rand 1985). The bioavailability of divalent metals in sediments has been shown to be a function of the acid volatile sulfide (AVS) content. Sulfides will bind to metals and create complexes which are highly insoluble, thus limiting their bioavailability (Hoffman et al. 1995). Water quality parameters such as pH and water hardness can also influence whether a metal will bioconcentrate by influencing metal speciation. Formation of organic compounds, for example via alkylation, will increase bioavailability.

Aquatic organisms do bioaccumulate metals. Organisms that preferentially feed in the sediments, e.g. detritus feeders like the crawfish, will contain higher metals concentrations than other organisms. It has also been observed that bioconcentration is greater at lower trophic levels (e.g., benthic invertebrates) than at higher trophic levels, such as pelagic fish. Biological activity may also play a significant role in the distribution of metals in the environment. Metals will also bioaccumulate in the roots of plants, presenting a potential exposure pathway for animals that feed on them.

Mercury - Mercury can exist in three stable oxidation states, as elemental mercury, mercurous ion and mercuric acid. Its existence in nature as elemental mercury is rare. It is also found as organic compounds bound to alkyl, phenyl and methoxyethyl radicals. In soil, adsorption of mercury is dependent on its chemical form. Inorganic mercuric complexes will significantly adsorb onto soils with high organic matter and are not expected to leach significantly. Mercury not adsorbed onto soils will volatilize, precipitate, leach or be taken up by plants. Most mercury in the aquatic environment is associated with sediments.

Biotransformation of mercury presents one of the more significant fate mechanisms in aquatic systems. Methylmercury, which has a high potential for bioaccumulation and bioconcentration in aquatic organisms because of its stability, is formed by bacterial methylation of inorganic mercury. Bacteria can accumulate mercury much faster than sediments, and aquatic organisms living on sediment bottoms have been observed to have higher mercury levels than those in the water column (Hoffman et al. 1995). Fish take in both inorganic mercury and methymercury and some higher species of fish can convert the inorganic form directly into the organic form. Greater than 80 percent of the mercury in fish tissue is in the form of methylmercury, whereas usually less than 60 percent of mercury in invertebrates is in the organic methylated form (Hoffman et al. 1995). BCF factors ranged from 75 for water boatmen to 29,000 for damselfly nymphs. Bioaccumulation in terrestrial ecosystems are less of a concern in that mercury is not readily transferred from soil to plants and other terrestrial organisms. Concern exists mainly for those terrestrial organisms that consume aquatic organisms as food.

Copper - Copper is considered among the more mobile of the heavy metals in surface waters and the least mobile in soil profiles. Speciation is an important factor in understanding both the fate of copper and its toxicity. Copper toxicity to animals has been shown to be related to Cu^{2+} and $CuOH^{+}$ species but not $Cu(CO_3)$ or $Cu(OH)_2$ (Rand 1985). Speciation of copper can vary considerably, depending on the type of complexation, adsorption, precipitation constituents and pH. Reducing or acidic environments such as rich organic sediment beds will remobilize copper. At a pH greater than 6, a high percentage of copper is removed from water. Copper has a strong affinity for hydrous iron and manganese oxides, clay, carbonate minerals, and organic matter, which tend to partition copper out of the water column and into soil and sediments. Among metals, copper is the most extensively complexed by humic materials, which generally reduces its toxicity. Copper is known to bioaccumulate. At low pH, copper is readily available to plants especially in soils low in organic and humic material.

1.4 General Ecotoxicity Mechanisms and Potential Ecological Receptors

1.4.1 Ecotoxicity of Contaminant Groups

Due to the large number of contaminants detected (92) in the sediments and surface water of Devil's Swamp and Bayou Baton Rouge, only a generalized discussion of the ecotoxicity of the major contaminant groups is presented below. Due to limited information on the toxicity of many of the contaminants to plants and microorganisms, the discussion focuses primarily on the ecotoxicity to animals. More detailed information is provided in Section 2.

Chlorinated Hydrocarbons

Effects of chlorinated hydrocarbons have been observed in birds, fish, mammals, and man. The primary target organs for this class of compounds are the liver and kidneys. For example, tetrachloroethene induced liver tumors when administered orally to mice and was found to be mutagenic using a microbial assay system. Chlorinated benzenes generally have moderate to high toxicities. The most toxic of this group are hexachlorobenzene (HCB), hexachlorobutadiene (HCBD), and hexachloroethane. Hexachlorobenzene is carcinogenic in mice, rats, and hamsters, causing liver tumors in all three species. Chronic exposure to low levels of HCBD caused kidney toxicity in rats; other studies have shown that exposure may affect the central nervous system and liver. HCB was also used as a fungicide and is potentially toxic to microorganisms. HCBD is also quite toxic to aquatic organisms. Thus, for chlorinated hydrocarbons, potential exposure pathways to aquatic organisms and mammals are of concern.

Polychlorinated Biphenyls (PCBs)

Documented effects of exposure to PCBs in aquatic organisms include decreased growth, reproductive toxicity, mutagenicity, histopathology, and a variety of biochemical perturbations. Reproductive toxicity has been reported for several aquatic species. Documented effects of PCBs in mammals include reproductive failure, physiological effects, altered behavior, and mutagenic, carcinogenic, and teratogenic effects. The most consistent pathological changes occurring in mammals after exposure to PCBs are in the liver. Reproductive effects on birds have also been documented. Effects also vary considerably based on specific PCB cogeners. Therefore, for PCBs, potential exposure pathways to aquatic organisms, mammals, and birds are important.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are chronically toxic to most aquatic organisms. Liver disorders in fish (Varanasi et al 1989); toxicity to benthic invertebrates (Landrum et al 1991) and other wildlife (Eisler 1987b) are documented. Adverse effects on the liver and kidney have been associated with exposure to PAHs in rodents. In addition, some PAHs are carcinogenic, causing tumors both at the site of application and systemically. The carcinogenic PAHs are generally active in mutagenic assays. They also cause skin disorders and immunosuppression. Potential exposure pathways to aquatic organisms and mammals would be of particular concern.

Pesticides

A variety of pesticides were detected at Devil's Swamp, including chlorinated pesticides. The chlorinated pesticides are persistent in the environment. They are acutely toxic to aquatic organisms. Some, such as DDT compounds, have been shown to be carcinogenic in mice. Many pesticides are also teratogenic and reproductive toxicants. Aldrin and dieldrin have been associated with large-scale kills of terrestrial wildlife in treated areas (Clement Assoc. 1985). DDT and other organochlorine pesticides are responsible for the decreased reproductive success of many bird species (Clement Assoc. 1985). Therefore, exposure to aquatic organisms, birds, and mammals to pesticides is of concern.

Other Organic Compounds

A variety of health effects have been observed in volatile organic compounds (VOCs), including liver and kidney effects, growth retardation, and reproductive effects. Reproduction toxicity was observed in pregnant rats and mice exposed to high concentrations of tetrachloroethene. Animals exposed by inhalation to this substance also exhibited liver, kidney, and central nervous system damage (Clement Assoc. 1985). Organism effects from many of the detected organic contaminants to aquatic plant and animal species have been documented in the federal quality criteria reference (USEPA 1986).

Studies on the toxicity of other semivolatile organic compounds (SVOCs) have been performed for rats, mice, and guinea pigs. Health effects observed include liver effects, reproductive-developmental toxicity (phthalates), and kidney effects.

For many of the other organic compounds detected in the bayou and swamp, potential exposure pathways to mammals is of particular interest.

Metals

Metals affect a variety of target organs and produce numerous types of ecological effects. For example, aquatic organisms are very susceptible to copper toxicosis, and effects which include decreased egg production, have been observed in birds. Adverse effects to plants can occur at high concentrations (generally one order of magnitude above local background level).

Mercury is one of the most toxic metals detected at Devil's Swamp. Both organic and inorganic forms of mercury are reported to be teratogenic and embryotoxic in experimental animals. Toxic effects also occur in the liver, heart, gonads, pancreas, and gastrointestinal tract. Inorganic mercury is generally less acutely toxic than organic mercury compounds, but it may adversely affect the central nervous system (Clement Assoc. 1985). Therefore, for metals, exposure pathways to aquatic organisms, birds, and mammals are likely for this site.

1.4.2 Ecological Receptors

Species of greatest concern are those listed as federal endangered species and/or designated as a Louisiana Special Animal by the Louisiana Natural Heritage Program. Examples of such species include the bald eagle (*Haliaetus leucocephalus*), the osprey (*Pandion haliaetus*), and the pallid sturgeon (*Scaphirynchus albus*). The bald eagle is known to nest year round while the osprey can nest in Louisiana but is not known to do so. The bald eagle feeds mostly on fish and other animals while the osprey preys mostly on fish. The pallid sturgeon is a benthic feeder and a migratory fish. It is native to Louisiana but is not likely to spawn in the area.

A high abundance and diversity of benthic invertebrates can be found in deep-water swamps. The dominant species are oligochaetes (*Limnodrilus, Peloscolix*), dipdtera insects (*Chaoborus, Chironomus*), and amphipods (*Hyalella*). Other species that are present include crawfish (*Procambarus*), clams (*Pisidium*), and snails (*Physa*).

Other species of concern are the nearctic river otter (*Lutra canadensis*) and the North American mink (*Mustela vison*). Both are year-round residents and breed within the wetlands. The foraging behavior of the otter has the potential to expose it to contaminated sediments within Devil's Swamp Lake and the distributary channels. The mink feeds around the swampy areas (riverine and deep-water swamp) and, like the otter, has a potential for exposure to contaminated sediments.

The selection of the receptors of concern for this SLRA was based on their potential for exposure, their likely duration of exposure (e.g., all year long versus seasonally), their feeding behavior (e.g., benthic feeder, piscivore), sensitivity to the contaminants of concern, and their status as a state or federally protected species, as well as the importance of their function in transporting contaminants higher into the food chain. Based on these factors the following receptors of concern were selected:

- Benthic detrital feeders/scavangers - invertebrates, such as the crawfish, that live and feed in the sediments and come in direct contact with contaminated sediments and water;

- Benthic fish - feed on epibenthic and benthic organisms; represented by the pallid sturgeon which is classified as a federal endangered species;

- Wetland shore bird - year-round resident and nester in Devil's Swamp; fish and aquatic organisms account for a large portion of their diet (up to 100 percent); represented by the great blue heron;

- Carnivorous bird - resident and nester in Devil's Swamp; fish, ducks, and small mammals comprise a large portion of their diet; represented by the bald eagle; and

- Terrestrial nearshore mammal - represented by the north American mink, is a resident breeder in Devil's Swamp; fish and aquatic organisms account for a large portion of their diet.

1.5 Exposure Pathways

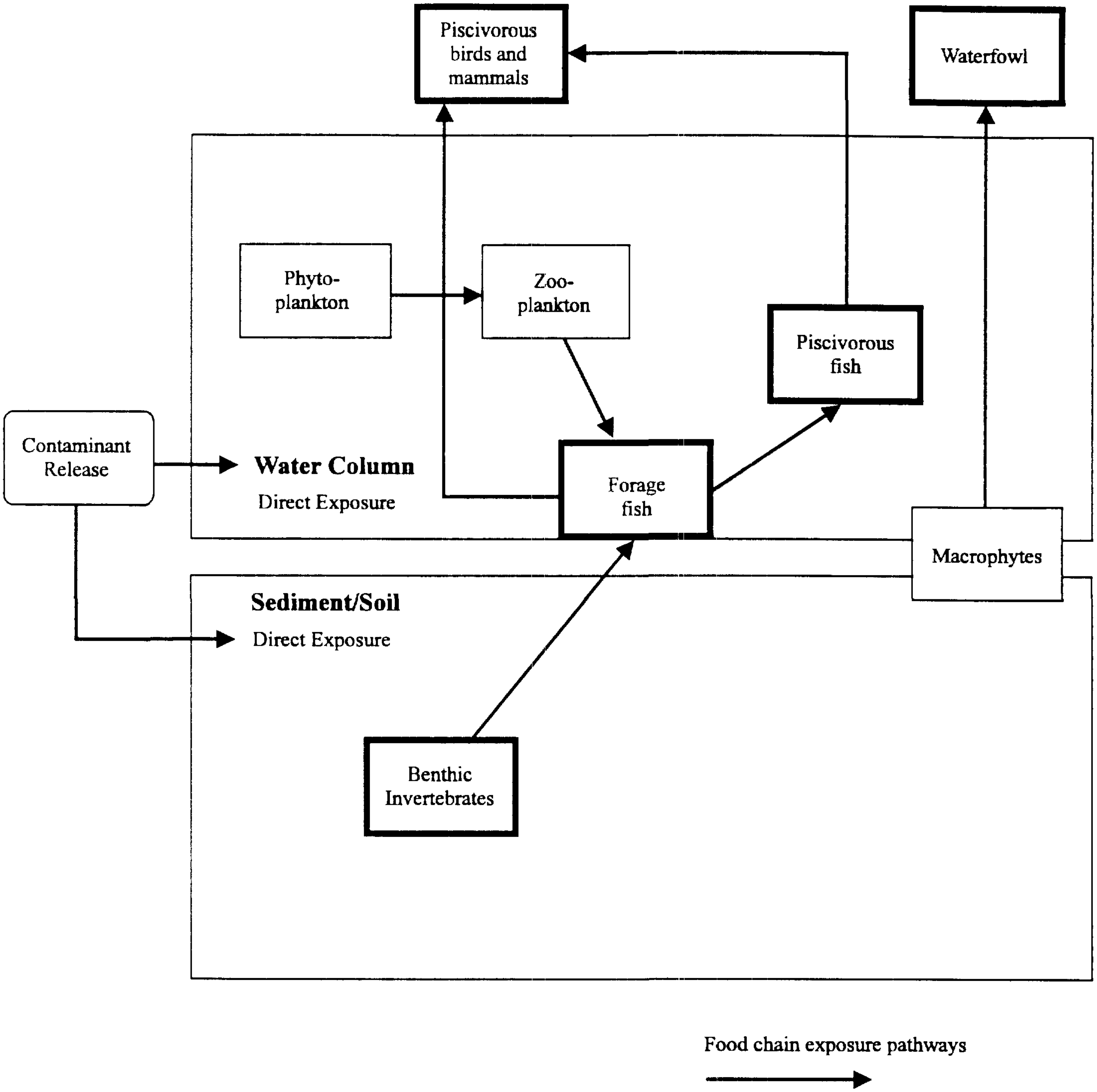
For the puposes of this SLRA, receptors of concern will be evaluated for exposure to site contaminants. The following paragraphs describe the likely exposure routes for each of these receptors, as well as their contribution to contaminant transport through the food web. These receptors were chosen to represent species which: 1) inhabit the contaminated media, 2) importance in transfering contaminants to other species, 3) representative of other species within their ecological niche, and 4) sensitivity to contaminants.

Figure 1-2 shows a simplified model of contaminant exposure pathways, including areas of potential biomagnification via the food chain. Other potential exposure pathways also exist, such as benthic invertebrates exposed to the water column; or, direct ingestion of benthic organisms by carnivorous birds and mammals. It is further assumed that contaminant transfer through the carnivorous food web is similar to a herbivorous food web. While these other pathways may also be important, they are not discussed in detail in this SLRA.

1.5.1 Benthic Detrital Feeders

Crawfish are opportunistic detrital feeders which are likely exposed to contaminants from many sources. Contact with sediments and surface water (including exposure to gills) constitutes a pathway for primary exposure to potential contaminants. Ingestion of sediments and contaminated food are also important exposure routes. The crawfish is an important food source for higher trophic levels, such as fish, birds and mammals (including humans), and likely transfers contaminants to higher organisms in the food web. The crawfish are omnivorous and will opportunistically feed on decaying vegetation, benthic or epibenthic invertebrates, fish, or any other available food sources which are exposed to potential contaminants.

Crawfish and other prey organisms may bioaccumulate hydrophobic contaminants in fatty tissues or other cellular structures through the lifetime of the organism. Likewise, vegetation will bioaccumulate these materials. Crawfish have the potentail to bioaccumulate contaminants, which can then biomagnify further up into the food chain. Therefore, the crawfish is evaluated because of the contaminant transport to and from herbivorous, carnivorous, other omnivorous, and detritivorus communities in the ecosytem. Direct effects to the crawfish are also important to evaluate because of its importance as a food source for higher trophic levels.



Adapted from Davis and Bascietto, 1993

Figure 1-2
Simplified Conceptual Model of Contaminant Pathways in Devil's Swamp

1.5.2 Benthic Fish

The Pallid Sturgeon, a federally protected species, is primarily a benthic carnivore and represents this receptor group. Exposure to potential contaminants in this species may occur through exposure to sediments and surface water (including exposure to gills), as well through ingestion of sediments and contaminated biota. Crawfish and other benthic organisms are likely consumed by this fish. The Pallid Sturgeon is an important representive species for the purposes of evaluating ecotoxity. This species will conservatively evaluate direct impacts to various catfish (as a surrogate), and will serve as a surrogate for food web transfer through catfish as well. Catfish were not evaluated because of known high tolerance to various contaminants. Therefore, to meet the objective of this SLRA, the Pallid Sturgeon is an appropriate surrogate benthic carnivore to evaluate ecotoxicity. As a surrogate for catfish, the Pallid Sturgeon will also evaluate food chain transfers to higher trophic levels; catfish are an important food source for many raptors and mammals (including humans).

1.5.3 Wetland Shore Bird

The Great Blue Heron was chosen to represent this receptor group. It is primarily a carnivorous feeder (USEPA 1993i). Primary exposure routes considered for this species are ingestion of contaminated biota, sediments/soils, and surface water.

Great blue herons are preferentially piscivorous, but will also eat amphibians, reptiles, crustaceans, birds and mammals. When fishing, the heron genenerally wades or swims in less than 0.5 m of water in areas of firm benthic substrate, and fish caught are generally less than 20 cm. Within the Devil's Swamp area, crawfish may also constitute a significant fraction of the heron's diet. In addition, a heron consumes water following ingestion of larger prey items (USEPA 1993i). The great blue heron is also an important indicator of the effects within higher trophic levels from bioconcentrating and biomagnifying contamination migrating through various benthic and pelagic aquatic communities.

1.5.4 Carnivorous Bird

The bald eagle, a federally protected endangered species, is primarily a carrion opportunistic feeder (USEPA 1993i). Primary exposure routes to this species are through ingestion of contaminated biota, sediments/soils, and surface water. The sensitive nature and protective status of this species, and its function within the ecosystem at the top of the food chain, are primary reasons for its selection.

Bald eagles eat dead or dying fish when available, but will also catch live fish near the water's surface (pelagic or shallow water benthic species). Bald eagles will also consume waterfowl and mammals. In general, this species will take advantage of whatever food source is most plentiful, easy to scavenge or easy to capture. Because of its feeding habits, the bald eagle is especially vulnerable to environmental contaminants and pesticides. For example, the eagle may feed on a bird which was sick from environmental toxins, thus bioconcentrating contaminants from select food sources (USEPA 1993i). The bald eagle is also an important indicator of the effects within higher trophic levels from bioconcentrating and biomagnifying contamination.

1.5.6 Terrestrial Nearshore Mammal

As a representative of this receptor group, the mink is primarily an opportunistic carnivore and will take advantage of whatever food source is most plentiful or easy to capture (USEPA 1993i). Primary exposure routes to this species are through ingestion of contaminated biota, sediment/soil, and surface water.

A nocturnal predator, the mink preferentially hunts mammals. The feeding habits of the mink will vary seasonally within the wetland habitat, depending on water levels and vulnerability of prey. The mink will hunt fish, amphibians and crustaceans, as well as other terrestrial species (i.e., birds, reptiles and insects). Another important prey species is the muskrat. The mink is also an important indicator of the effects within higher trophic levels from bioconcentrating and biomagnifying contamination migrating through various aquatic communities, as well as through terrestrial communities closely linked to the marsh habitat.

1.5.7 Complete Exposure Pathways

Based on the discussion above and the simplified conceptual model (Figure 1-2), several exposure pathways are considered complete (i.e., pathways for those contaminants that can reach ecological receptors). These are:

- Direct contact of aquatic organisms to contaminated surface water. This includes plant absorption and contact through gills/dermis of fish;
- Direct contact and ingestion of contaminated sediments to benthic invertebrates;
- Contaminant transfers to other trophic levels via ingestion of prey and sediments and/or surface water.

The inhalation pathway of volatile contaminants to terrestrial organisms is least understood due to the lack of air data and unknown significance of the volatilization fate of these contaminants relative to organism exposure.

2.0 PRELIMINARY ECOLOGICAL EFFECTS EVALUATION

2.1 Ecological Effects of Chemical Contaminants

Contaminants in Devil's Swamp/Bayou Baton Rouge may adversely affect receptors that directly contact or ingest surface water or sediments. Toxicity mechanisms include acute and chronic effects from direct exposure, and chronic effects due to exposure through bioaccumulation. Receptors that may be directly affected under short-term exposure include benthic infauna, benthic epifauna, and larval and juvenile forms of other aquatic organisms such as fish and amphibians. Common adverse acute and chronic effects measurable for these receptor types include mortality, growth and reproductive impairment, and behavioral changes. Higher trophic level biota affected over longer exposure duration (through bioaccumulation and/or biomagnification of contaminants) include omnivorous and carnivorous fishes, mammals, birds, reptiles, and amphibians. In addition to measurable chronic effects for receptors at lower levels of biological organization, other subtle, long-term, adverse effects may occur at these levels of organization including population declines from reproductive impairment, shifts in community composition and diversity, and increased susceptibility to natural stressors through suppression of immune systems.

There are numerous ecotoxicity references for invertebrates, plants, fish, birds, and mammals that may be relevant to the contaminants detected in Devil's Swamp. However, only a brief ecotoxicity profile of the contaminant groups is provided below, and is not intended to be comprehensive for this SLRA.

2.1.1 Chlorinated Hydrocarbons

HCB and HCBD are the chlorinated hydrocarbons of most concern at Devil's Swamp. The acute toxicity of HCB is low, however the sub-acute and chronic toxicity of HCB is much greater. The single oral lethal dose that resulted in a 50 percent mortality (LC_{50}) for *Coturnix* quail is greater than 1,000 mg/kg; in 3-month feeding studies, Vos et al. established a LOEL of 1 mg/kg (due to histopathological effects) for *Coturnix* (Newell 1987). HCB has been demonstrated to be carcinogenic in laboratory animals, and there is equivocal evidence suggesting that HCB is teratogenic at high doses in rats and mice. Developmental effects have been observed at doses as low as 0.08 mg/kg-d in rats. Field studies of predatory and specifically piscivorous birds showed some correlation between increased tissue HCB concentrations and increased mortality, low breeding success, and increased porphyria (Clement Assoc. 1985).

Hexachlorobutadiene (HCBD) is very toxic to aquatic organisms, with 96-hour LC_{50} values for goldfish, rainbow trout, fathead minnow, and bluegill ranging from 0.09 to 0.33 mg/L. HCBD is toxic to experimental animals when inhaled, ingested, injected, or absorbed through the skin. It affects the central nervous system and causes hepatic disorders. Because HCBD is a cumulative toxin in mammals, the kidney is the most sensitive organ to HCBD. Data on reproductive toxicity are equivocal and there is limited evidence that HCBD is carcinogenic in mammals (Clement Assoc. 1985, ATSDR 1994b). Two studies were found reporting the toxicity of HCBD in avian species. Ingestion of up to 5 mg/kg-d reportedly had no observable effects (CESARS 1994, Newell 1987).

2.1.2 PCBs

The toxicity of PCBs increases with length of exposure and position of the exposed species on the food chain. The toxicity of the various PCB mixtures is also dependent on their composition. The 96-hour LC_{50} values for rainbow trout, bluegills, and channel catfish were approximately 20 mg/L. Invertebrate species were also adversely affected, with some species having 7-day LC_{50} values as low as 0.001 mg/L. In general, juvenile organisms appeared more susceptible to the effects of PCBs than adults or eggs (Clement Assoc. 1985).

There are three main ways in which PCBs can affect terrestrial wildlife: mortality, adverse effects on reproduction, and behavioral changes. PCB doses greater than 10 mg/kg body weight caused some mortality in sensitive bird species exposed for several days. Doses around 100 mg/kg body weight caused extensive mortalities in these species (Clement Assoc. 1985). Some mammals (e.g., mink) are particularly susceptible to PCBs. In birds, PCBs caused lower egg production; deformities; decreased hatchability, growth, and survival; and some eggshell thinning in reproductive studies on chickens. Behavioral effects on wildlife include increased activity, decreased avoidance response, and decreased nesting, all of which could significantly influence survival in the wild.

PCBs appear to have a low order of acute lethality. Data for PCB mixtures and specific PCB isomers suggest that mice and guinea pigs are more sensitive than rats. Aroclors are lethal at much lower total doses when administered subchronically or chronically than acutely, indicating that PCBs tend to bioaccumulate to concentrations that are toxic (ATSDR 1989).

Animal studies have shown that the liver and cutaneous tissues are the major target organs for PCBs. PCBs have also been shown to produce stomach and thyroid alterations, immunosuppressive effects, and porphyria in animals. Animals are sensitive to repeated exposures to PCBs as a result of rapid bioaccumulation to toxic levels.

PCBs appear to be fetotoxic but not teratogenic in various species of animals, including rats, mice, rabbits, and monkeys. Oral exposures to PCBs produced deleterious effects on reproduction in monkeys, mink, and, at higher doses, rodents (ATSDR 1989). Mink, a species particularly sensitive to PCBs, when fed a diet containing as little as 0.096 mg/kg-d exhibited reproductive failure (Newell 1987). Feeding studies in laboratory animals demonstrated the carcinogenicity of several PCB mixtures, but it is not clear which components of the PCB mixture are actually carcinogenic. The liver is the primary target of PCB carcinogenicity.

2.1.3 PAHs

Detailed information regarding the environmental toxicity of PAHs to aquatic organisms is fairly recent and much has been done with quantitative structure activity relationships and tissue residue effect levels. The principle mode of toxicity is narcosis to aquatic organisms. PAHs have been found to be carcinogenic in several animal species and have both local and systemic carcinogenic effects. Carcinogenic PAHs produced tumors of the forestomach in mice. Skin application of PAHs produced skin carcinomas in mice. Studies in other species, while indicating carcinogenic effects, are less complete. Carcinogenic PAHs have been reported to be mutagenic in various test systems. Limited available data indicate that PAHs are not very potent teratogens or reproductive toxins (Clement Assoc. 1985).

There is little available information regarding noncancer changes caused by exposure to PAHs in mammals. Application of carcinogenic PAHs to mouse skin reportedly caused destruction of sebaceous glands, hyperplasia, hyperkeratosis, and ulceration. Some carcinogenic PAHs also have immunosuppressive effects.

2.1.4 Pesticides

A variety of pesticides were detected at Devil's Swamp. Descriptions of DDT, aldrin, dieldrin, endrin, and compounds are presented as examples of the potential toxic effects of pesticides.

DDT has been extensively studied in freshwater invertebrates and fishes and is quite toxic to most species. The range of toxicities was 0.18 to 1,800 ug/L. DDT, DDD, and DDE and other persistent organochlorine pesticides are primarily responsible for the great decrease in the reproductive capabilities and therefore in the populations of fish-eating birds, such as the bald eagle, brown pelican, and osprey. DDT has also been shown to decrease the populations of numerous other species of waterbirds, raptors, and passerines (Clement Assoc. 1985).

Aldrin and dieldrin are both acutely toxic to freshwater species at low concentrations. Tests in fish showed that the two chemicals had similar toxicities, with LC_{50} values ranging from 1 to 56 ug/L for different species. Chronic studies have been conducted on the effects of dieldrin on freshwater species. Chronic values as low as 0.2 ug/L were obtained. No chronic studies were performed on aldrin, but because its acute toxicity is comparable to that of dieldrin and because it is readily converted to dieldrin in animals and in the environment, its chronic toxicity is probably similar (Clement Assoc. 1985). Both pesticides, and especially dieldrin, have been associated with large-scale bird and mammal kills in treated areas (Clement Assoc. 1985). Experimental feeding studies have shown that the chemicals are quite toxic to terrestrial wildlife at low levels.

Endrin is very toxic to aquatic organisms. Freshwater fish are generally more sensitive than invertebrates, with species mean acute values ranging from 0.15 to 2.1 ug/L. Endrin is acutely toxic to terrestrial wildlife and has been used as a rodenticide and an avicide. It can also cause central nervous system effects and reproductive disorders following chronic exposure. Sublethal effects observed in animals exposed to endrin include abnormal behavior, increased postnatal mortality, and increased fetal death.

2.1.5 Other Organic Compounds

Little information on the toxicity of VOCs to terrestrial wildlife species was available in the literature reviewed. Tetrachloroethene is the most toxic of the chloroethenes to aquatic organisms, but is only moderately toxic relative to other types of compounds. The limited acute toxicity data indicate that the LC_{50} value for freshwater species is around 10,000 ug/L; the trout was the most sensitive species (Clement Assoc. 1985).

2.1.6 Metals

A number of studies have examined the toxicity and impact of metals on aquatic invertebrates, including *Daphnia*, gastropods, and aquatic insects. Mercury and cadmium are usually the most toxic metals, whereas zinc and nickel are less toxic. However, responses to heavy metals vary considerably, depending on the organisms involved and environmental conditions (Keller 1991).

The data show that although shellfish (mostly bivalves) can accumulate high levels of metals from their environment and live for some time, they may also be adversely affected (e.g., reproductive decline) by much lower concentrations (Keller 1991).

Water hardness has a major effect on metal toxicity to fish and shellfish, which has been demonstrated for many organisms and is related to metal chelation and to physiological responses of the organisms. First, metals become less soluble in hard water as they form complexes with carbonates. Second, water hardness, caused primarily by Ca^{2+} and Mg^{2+}, may decrease membrane permeability and, therefore, uptake of metals from water. The impact of water hardness on metal toxicity has been noted in studies with various aquatic species. Metal solubility and therefore bioavailability are decreased in hard water (i.e., metals are more toxic in soft water) (Keller 1991).

The toxicity of low concentrations of metal mixtures has not been explicitly considered in this evaluation. However, metals can be more toxic to aquatic life at lower concentrations in combination than they are singly (Keller 1991).

Two metals with relatively high aquatic toxicities that were detected at Devil's Swamp include copper and mercury. These are described in more detail below.

Copper has mean acute toxicity values for a large number of freshwater animals ranging from 0.0072 mg/L for *Daphnia* to 10.2 mg/L for bluegill. Toxicity tends to decrease as hardness, alkalinity, and total organic carbon increase. Chronic values for a variety of freshwater species range from 0.0039 mg/L for brook trout to 0.060 mg/L for northern pike. Copper does not appear to have mutagenic, teratogenic, or carcinogenic effects in animals. Various effects, including altered enzyme metabolism, decreased weight gain, organ pathology, and decreased egg production in birds have been observed at doses as low as 6.3 mg/kg-d (CESARS 1994).

The toxicity of mercury compounds has been tested in a wide variety of aquatic organisms. Although methylmercury appears to be more toxic than inorganic mercuric salts, few acute or chronic toxicity tests have been conducted with it (Clement Assoc. 1985). For freshwater species, the 96-hour LC_{50} values for inorganic mercuric salts range from 0.00002 mg/L for crawfish to 2.0 mg/L for caddisfly larvae. Acute values for methylmercuric compounds and other mercury compounds are only available for fish. In rainbow trout, methylmercuric chloride is about ten times more toxic to rainbow trout than mercuric chloride, which is acutely toxic at about 0.3 mg/L. Methylmercury chronic value for brook trout is 0.001 mg/L. Chronic dietary exposure of chickens to mercuric chloride at growth inhibitory levels causes immune suppression, with a differential reduction effect on specific immunoglobulins.

2.2 Ecotoxicity Screening Values

2.2.1 Surface Water

Ecotoxicity screening values, also known as screening toxicity reference values (TRVs), for surface water consist of federal and state ambient water quality criteria (AWQC) for the protection of aquatic life. The AWQC were derived to be protective for most aquatic organisms in an area of exposure.

Since the chronic freshwater AWQC values for certain metal contaminants are hardness dependant, the criteria for these metals were normalized using the appropriate referenced equations, and a hardness value of 50 mg/L as calcium carbonate. This hardness value was selected as a conservative estimate based on the lowest measured hardness value reported for the site (54.5 mg/L) in a filtered surface water sample (LDEQ 1993).

Additional literature information was reviewed on those chemicals for which no AWQC are available. Toxicity data were compiled and conservative values were selected as TRVs. Whenever possible, the toxicity endpoint used as a TRV was a No Observed Adverse Effect Level (NOAEL) for chronic or subchronic exposures. For this SLRA, an uncertainty factor of 10 was used to extrapolate from a Lowest Observed Adverse Effect Level (LOAEL) to NOAEL endpoints and from subchronic to chronic endpoints. An uncertainty factor of 100 was used to extrapolate from single oral doses and acute LD_{50} data to chronic NOAELs (Calabrese 1993).

Screening level TRVs in surface water are presented in Table 2-1. Only those chemicals detected in surface water are presented.

Table 2-1
Surface Water Screening Level TRVs

Chemical	Maximum Conc. in Surface Water (mg/L)	Surface Water TRV (mg/L)	TRV Source
Chlorinated Hydrocarbons			
Hexachlorobutadiene	0.074	0.0093	A
PAHs			
2-Methylnaphthalene	0.003	0.6	H
Naphthalene	0.003	0.62	B
Pesticides			
beta-BHC	0.000009	--	
Endrin	0.000004	0.0000023	C
Heptachlor epoxide	0.000002	0.0000038	B
Other Organic Compounds: Volatiles			
1,1,2,2-Tetrachloroethane	0.017	2.4	A
1,1,2-Trichloroethane	0.15	9.4	A
1,1-Dichloroethene	0.006	29	D
1,2-Dichloroethane	0.38	20	A
1,2-Dichloroethene	0.078	140	L
1,2-Dichloropropane	0.14	138	E
2-Butanone	0.03	320	K
Acetone	0.066	100	K
Methylene chloride	0.009	193	K
Tetrachloroethene	0.008	0.84	A
Toluene	0.01	9.4	F
Trichloroethene	0.032	21.9	A
Vinyl chloride	0.06	--	
Xylenes (Total)	0.003	13.5	G
Other Organic Compounds: Semivolatiles			
Bis(2-ethylhexyl)phthalate	0.001	0.36	B

Table 2-1 (Continued)
Surface Water Screening Level TRVs

Chemical	Maximum Conc. in Surface Water (mg/L)	Surface Water TRV (mg/L)	TRV Source
Di-n-butylphthalate	0.001	0.003	B
N-Nitrosodiphenylamine	0.004	0.009	I
Metals			
Aluminum	3.48	0.087	B
Barium	0.121	410	J
Cadmium	0.0086	0.00066	C
Chromium	0.0045	0.12	C
Copper	0.0095	0.0065	C
Iron	3.28	1	B
Lead	0.0829	0.0013	C
Magnesium	7.86	--	
Manganese	1.69	--	
Mercury	0.107	0.000012	B
Potassium	10.3	--	
Selenium	0.0022	0.005	B
Vanadium	0.0273	--	

Table 2-1 (Continued)
Surface Water Screening Level TRVs

-- indicates no information is available.

Sources:

A Freshwater chronic LEC for aquatic organisms; LEC values are not criteria but are the lowest effects levels found in the literature. LECs are given when the minimum data required to derive water quality criteria are not available (USEPA 1986).
B Federal ambient water quality criteria: aquatic organisms, freshwater, chronic (USEPA 1986).
C Federal ambient water quality criteria: aquatic organisms, freshwater, chronic; hardness dependent. Values listed are for water hardness level of 50 mg/L as CaCO3 (USEPA 1986).
D Based on 13-day LC_{50} for fathead minnow (AQUIRE 1994).
E Based on 96-hr LC_{50} for fathead minnow (Vittozzi, DeAngelis 1991).
F Based on 7-day LC_{50} for fathead minnow (AQUIRE 1994).
G Based on 96-hr LC_{50} for bluegill (AQUIRE 1994).
H Based on 96-hr LC_{50} for shrimp (AQUIRE 1994).
I Based on 14-day LC_{50} for bluegill (AQUIRE 1994).
J Based on 48-hr LC_{50} for water flea (AQUIRE 1994).
K Based on 96-hr LC_{50} for fathead minnow (AQUIRE 1994).
L Based on 96-hr LC_{50} for bluegill (AQUIRE 1994).

2.2.2 Freshwater Sediments

A variety of sediment quality values and guidelines were used to evaluate sediment quality and potential ecological risks from contaminated freshwater sediments. Screening TRVs were developed to be protective of organisms, including crawfish, in freshwater sediments; they are based on chronic, long-term effects to benthic organisms. The following sources were used in developing freshwater sediment TRVs:

- Federal Sediment Quality Criteria for nonionic organic contaminants for the protection of benthic organisms (USEPA 1993a,b,c,d,e,f,g,h);

- Draft Freshwater Sediment Apparent Effects Thresholds (WSDOE 1994);

- Effects Range-Low (ER-L) Guidelines (Long and Morgan 1990, Long et al. 1993); and

- Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (Persaud et al. 1993).

The sediment evaluation process was conducted in a tiered fashion. First, sediment chemical concentrations were compared to EPA's Federal Sediment Quality Criteria (SQC). These SQC are based on the equilibrium partitioning approach, which relates AWQC to sediment contaminant concentrations in organic carbon. If no federal SQC were available, the Washington State freshwater sediment apparent effects threshold (AETs) were used. The AET is defined as the concentration of a given chemical above which a statistically significant ($P < 0.05$) biological effect (e.g., mortality) always occurs. The AET value identifies the upper boundary of a chemical concentration that may be tolerated by a given organism. The AETs are based on biotoxicity testing (using *Hyalella azteca* and Microtox) in freshwater sediments from Washington and Oregon (WSDOE 1994). An AET derived from *H. azteca* is appropiate as this genus of amphipods resides in Devil's Swamp.

A TOC value of 1,600 mg organic carbon/kg (or 0.16 percent) was measured at bayou sampling location B1 (NPC Services 1993). This is the only sampling location for which a TOC value has been reported. Because of the lack of sufficient TOC data to determine an appropriate site-specific TOC value, a TOC value of 0.2 percent was conservatively used in this SLRA to normalize EPA and AET values to the TOC content at the site.

Chemicals with no SQC or draft AETs were compared to other available values, including ER-L values and Ontario Provincial sediment quality guidelines (Long and Morgan 1990, Long et al. 1993, Persaud et al. 1993). To assist in evaluating sediment monitoring data collected nationally, The National Oceanic and Atmospheric Administration (NOAA) (Long and Morgan 1990) established guidelines of ER-L, which is the 10th percentile and of an array of sediment data assembled for review. The ER-L values are concentrations above which adverse effects may begin or are predicted among sensitive life stages or species, or as determined in sublethal tests. The 1990 ER-L values were updated in 1992 based upon an expanded database and a refined approach (Long et al. 1993).

The Ontario sediment quality guidelines, developed primarily for the Great Lakes, define three levels of chronic, long-term effects on benthic organisms: 1) a no-effect level, where no toxic effects have been observed on fish or sediment-dwelling organisms (derived by equilibrium partitioning); 2) a lowest-effect level, which indicates a level of sediment contamination that can be tolerated by most benthic organisms; and 3) a severe effect level, where pronounced disturbance of sediment-dwelling organisms can be expected. In this SLRA, the no-effect level and/or lowest-effect level were used to develop TRVs.

Screening level TRVs in freshwater sediments are presented in Table 2-2. The TRVs used in this SLRA are highlighted. Of the 92 contaminants detected in Devil's Swamp/Bayou Baton Rouge, only 44 have screening level TRVs.

2.2.3 Ecotoxicity Values for Avians and Mammals

Ecotoxicity screening values were developed for mammalian and avian receptors for those chemicals detected in Devil's Swamp. These screening TRVs, are based on toxicity information found in the literature. The primary sources for the toxicity information include:

- Toxicological profiles developed by the Agency for Toxic Substances and Disease Registry (ATSDR 1990, 1994a,c,d)
- Series of contaminant hazard reviews published by the U.S. Fish and Wildlife Service (Eisler 1986a,b; 1987a,b; 1988a,b)
- Computer databases provided by the Chemical Information System (CIS), including the Integrated Risk Information System (IRIS) database, the Chemical Evaluation Search and Retrieval System (CESARS), and the Aquatic Information Retrieval (AQUIRE) database (USEPA 1995, CESARS 1994, AQUIRE 1994).

For each complete exposure route, a preliminary literature survey was conducted to determine the lowest level of exposure (e.g., concentrations in water or in the diet) shown to produce adverse effects (i.e., a lowest-observed-adverse-effect-level or LOAEL). Adverse effects of most concern include reduced growth, impaired reproduction, and increased mortality in potential receptor species. In addition, the highest exposure level at which no adverse effects have been demonstrated (i.e., the no-observed-adverse-effect-level or NOAEL) was identified. For this initial screening estimate, a NOAEL was judged to be more appropriate than a LOAEL to ensure that risk is not underestimated. However, NOAELs are not currently available for many wildlife species or many chemicals. In many cases, toxicity data from a related species was used to estimate a NOAEL for a receptor species.

Table 2-2
Freshwater Sediment Screening Level TRVs

Chemical	Maximum Conc. in Sediment (mg/kg)	Federal Sediment Quality Criteria[a] (mg/kg organic carbon)	Federal Sediment Quality Criteria (Normalized) (mg/kg in sediment)[b]	Freshwater AETs[c] (mg/kg organic carbon)	Freshwater AETs (Normalized) (mg/kg in sediment)[b]	Effects Range Low (ERL) (mg/kg in sediment)[d]	Ontario Sediment Quality Criteria - No Effects Level (mg/kg in sediment)[e]	Ontario Sediment Quality Criteria - Lowest Effects Level (mg/kg in sediment)[f]
Chlorinated Hydrocarbons								
Hexachlorobenzene	470						0.01	0.02
PCBs								
Aroclor-1248	5.2							0.03
Aroclor-1254	6.4			18	0.036			0.06
Aroclor-1260	3							0.005
Total PCBs	13.3			37	0.074	0.023	0.01	0.07
PAHs								
Acenaphthene	2.5	130	0.26	3400	6.8	0.016		
Acenaphthylene	1.1			83	0.17	0.044		
Anthracene	2.3			1700	3.4	0.085		0.22
Benzo(a)anthracene	3			650	1.3	0.26		0.32
Benzo(a)pyrene	0.56			910	1.8	0.43		0.37
Benzo(g,h,i)perylene	0.073			910	1.8			0.17
Benzo(k)fluoranthene	0.74							0.24
Chrysene	4			1700	3.4	0.38		0.34
Fluoranthene	7.5	620	1.2	4800	9.6	0.6		
Fluorene	13			4200	8.4	0.019		0.19
Naphthalene	50			2300	4.6	0.16		
Phenanthrene	340	180	0.36	9100	18.2	0.24		

Table 2-2 (Continued)
Freshwater Sediment Screening Level TRVs

Chemical	Maximum Conc. in Sediment (mg/kg)	Federal Sediment Quality Criteria[a] (mg/kg organic carbon)	Federal Sediment Quality Criteria (Normalized) (mg/kg in sediment)[b]	Freshwater AETs[c] (mg/kg organic carbon)	Freshwater AETs (Normalized) (mg/kg in sediment)[b]	Effects Range Low (ERL) (mg/kg in sediment)[d]	Ontario Sediment Quality Criteria - No Effects Level (mg/kg in sediment)[e]	Ontario Sediment Quality Criteria - Lowest Effects Level (mg/kg in sediment)[f]
Pyrene	10			3100	6.2	0.67		0.49
Pesticides								
Aldrin	0.61							0.002
alpha-BHC	0.0036							0.006
alpha-Chlordane	0.051					0.0005	0.005	0.007
beta-BHC	0.0038							0.005
Dieldrin	0.00028	11	0.022			0.00002	0.0006	0.002
Endrin	0.0022	4.2	0.0084			0.00002	0.0002	0.003
gamma-BHC (Lindane)	0.0065						0.0002	0.003
gamma-Chlordane	0.011						0.005	0.007
Heptachlor epoxide	0.17							0.005
Other Organic Compounds: Semivolatiles								
Bis(2-ethylhexyl)phthalate	5.9			750	1.5			
Di-n-butylphthalate	1.9			20	0.04			
Metals								
Aluminum	36,100			27000[g]				
Arsenic	618			150[g]		8.2		6
Cadmium	62.3			12[g]		1.2		0.6
Chromium	94.8			280[g]		81		26
Cobalt	113							50
Copper	929			840[g]		34		16

Table 2-2 (Continued)
Freshwater Sediment Screening Level TRVs

Chemical	Maximum Conc. in Sediment (mg/kg)	Federal Sediment Quality Criteria[a] (mg/kg organic carbon)	Federal Sediment Quality Criteria (Normalized) (mg/kg in sediment)[b]	Freshwater AETs[c] (mg/kg organic carbon)	Freshwater AETs (Normalized) (mg/kg in sediment)[b]	Effects Range Low (ERL) (mg/kg in sediment)[d]	Ontario Sediment Quality Criteria - No Effects Level (mg/kg in sediment)[e]	Ontario Sediment Quality Criteria - Lowest Effects Level (mg/kg in sediment)[f]
Iron	49,000							20,000
Lead	1,410			720[g]		46.7		31
Magnesium	8,690			6100[g]				
Manganese	1,870			1800[g]				460
Mercury	0.65			2.7[g]		0.15		0.2
Nickel	140			31[g]		20.9		16
Selenium	0.92			0.1[g]				
Silver	11.8			4.5[g]		1.0		0.5
Zinc	1,820			1100[g]		150		120

SOURCES:

a Federal sediment quality criteria for the protection of benthic organisms; based on equilibrium partitioning method (EPA 1993a,b,c,d,e,f,g,h).
b For normalization, an organic carbon fraction of 0.2% was conservatively assumed
c Washington Department of Ecology preliminary freshwater apparent effects thresholds (Hyalella, except Microtox was used for Ni, BEHP) (WSDOE 1994)
d From Long et al. (1993). For those chemicals not included in the 1993 update, the value from Long and Morgan (1990) was used
e No Effect Level from Persaud et al. (1993). Indicates a level at which no toxic effects have been observed on fish or sediment-dwelling organisms. There is no expected food chain biomagnification, and all water quality guidelines will be met. Derived by the equilibrium partitioning method.
f Lowest Effect Level from Persaud et al. (1993). Indicates a level of sediment contamination that can be tolerated by most benthic organisms. Derived by the screening level concentration method.
g mg/kg in sediment

If a NOAEL value was not available (or the NOAEL did not represent a significant toxicological endpoint), and an appropriate LOAEL was found in the literature, the LOAEL was multiplied by 0.1 to estimate the NOAEL. Similarly, if only acute toxicity data were available for a particular chemical, the LD_{50} data were multiplied by 0.01 to estimate a chronic NOAEL.

An attempt was made to utilize toxicity studies conducted with the receptor species of concern, or very closely related species. However, the majority of the toxicity data used in the development of the TRVs are based on studies using conventional laboratory test animals such as rats, mice, ducks, and quail. No intertaxon uncertainty factor was applied in the development of TRVs.

Some data in laboratory studies are reported in terms of concentration in the diet (i.e., mg contaminant/kg diet). Diet concentrations were converted to dose (i.e., mg contaminant/kg body weight per day) so that dose is not under- or overestimated when it is applied to an organisms consuming different amounts of food per body weight. Average ingestion rate and body weight for a species were often reported in the relevant studies or were obtained (or estimated) from other literature sources.

No TRVs for phytotoxicity have been developed during this screening level risk assessment. Although concentrations of some chemicals in sediments could potentially affect plants, toxicity to animals is believed to be greater. Therefore, the focus of this assessment is on animals.

Tables 2-3 and 2-4 summarize screening level TRVs representative of contaminants in mammals and birds, respectively.

2.2.4 Uncertainty in Derivation of TRVs

For sediments, certain TRVs may not be applicable to the given sediment concentration. Values compared with equilibrium partitioning values depend on the accuracy of the partitioning coefficients and the extrapolation to various organisms.

The comparison to TRVs represents an indirect measure of potential toxicity from individual chemicals; it does not provide information regarding how chemicals may interact in the environment.

For many chemicals, toxicity data was not available for the receptor species. In many cases, the TRVs are based on studies using conventional laboratory test animals such as rats, mice, ducks, and quail. There is considerable uncertainty in the application of these data to the receptor species.

Table 2-3
Mammalian Oral Screening Level TRVs

Chemical	Species	Endpoint	Effect	TRV (mg/kg-d)	Reference
Chlorinated Hydrocarbons					
1,2,4-Trichlorobenzene	Monkey	NOAEL	Mortality	25	M
1,2-Dichlorobenzene	Rat	NOAEL	Hepatocellular necrosis	125	A
1,4-Dichlorobenzene	Rat	NOAEL	None reported	40	B
Chlorobenzene	Rat	NOAEL	Liver histopathology	60	A
Hexachlorobenzene	Rat	NOAEL	Developmental effects: liver chromogenesis	0.08	L
Hexachlorobutadiene	Rat	NOAEL	Renal tubular degeneration; hepatic alterations	3	B
Hexachloroethane	Rat	NOAEL	Atrophy and degeneration of the renal tubules	1	A
PCBs					
Aroclor 1254	Mink	LOEL	Reproductive failure	0.0096	M
Aroclor 1260	Rat	LOAEL	Body weight loss, liver weight gain, increased lymphocytes	0.5	B
Total PCBs	Mink	LOEL	Reproductive failure	0.0096	M
PAHs					
2-Methylnaphthalene	Rat	LD_{50}	Mortality	16.4	G
Acenaphthene	Mouse	NOAEL	Hepatotoxicity	175	A
Anthracene	Mouse	NOEL	None reported	1,000	A
Benzo(a)anthracene	Mouse	NOAEL	Developmental effects; viability of litter	10	H
Benzo(a)pyrene	Mouse	NOAEL	Developmental effects; viability of litter	10	H
Benzo(b)fluoranthene	Mouse	NOAEL	Developmental effects; viability of litter	10	H
Benzo(g,h,i)perylene	Mouse	NOAEL	Developmental effects; viability of litter	10	H

Table 2-3 (Continued)
Mammalian Oral TRVs

Chemical	Species	Endpoint	Effect	TRV (mg/kg-d)	Reference
Benzo(k)fluoranthene	Mouse	NOAEL	Developmental effects; viability of litter	10	H
Chrysene	Mouse	NOAEL	Developmental effects; viability of litter	10	H
Fluoranthene	Mouse	NOAEL	Nephropathy, hematological alterations, increased liver weights	125	A
Fluorene	Mouse	NOAEL	Decreased RBC, packed cell volume and hemoglobin	125	A
Naphthalene	Rat	NOAEL	None reported	36	B
Phenanthrene	Rat	LOAEL	Enzyme activity	10	B
Pyrene	Mouse	NOAEL	Kidney effects	75	A
Pesticides					
4,4'-DDD	Rat	NOAEL	Respiratory, CV, hepatic, GI effects	107	K
4,4'-DDE	Rat	LOAEL	Hepatic necrosis	4.2	K
Total DDT	Mink	LOAEL	Embryo mortality	0.04	J
Aldrin	Rabbit	NOEL	Mortality	0.063	M
beta-BHC	Rat	NOAEL	None reported	6.0	B
delta-BHC	Rat	LD_{50}	Mortality	10	I
Chlordane	Rat	NOEL	Liver histopathological effects	1.0	M
Dieldrin	Rat	LOEL	Maternal mortality	0.06	M
Endosulfan I and II	Rabbit	LEL	Maternal toxicity	0.18	A
Endosulfan sulfate	Rat	LD_{50}	Mortality	0.18	G
Endrin	Dog	NOEL	Organ damage	0.075	M
Endrin aldehyde	Rat	LOAEL	Not reported	0.25	B
Endrin ketone	Rat	LOAEL	Not reported	0.25	B

Table 2-3 (Continued)
Mammalian Oral TRVs

Chemical	Species	Endpoint	Effect	TRV (mg/kg-d)	Reference
gamma-BHC	Rat	NOAEL	Liver and kidney toxicity	0.33	A
Heptachlor epoxide	Dog	LEL	Reproductive effects (pup survival)	0.018	A
Methoxychlor	Rat	NOEL	Maternal toxicity; decreased litter size	10	A
Other Organic Compounds: Volatiles					
1,1,1-TCA	Rat	LOAEL	Mortality; reduced growth	75	B
1,1,2,2-Tetrachloroethane	Rat	LOAEL	Abnormal growth	6.2	B
1,1,2-TCA	Mouse	NOAEL	Clinical serum chemistry	3.9	A
1,1-DCE	Rat	LOAEL	Hepatic lesions	0.9	A
1,2-DCE	Rat	NOAEL	Early mortality; weight loss in females	251	B
2-Butanone	Rat	NOAEL	Decreased fetal birth weight	1771	A
Acetone	Rat	NOEL	Nephrotoxicity; increased liver and kidney weights	100	A
Benzene	Rat	NOAEL	Leuco- and erythrocytopenia	1.0	B
Carbon disulfide	Rat	LD50	Mortality	1.0	B
Chloroform	Dog	LOAEL	Fatty cyst formation in liver	1.3	A
Ethylbenzene	Rat	NOAEL	None reported	136	B
Methylene chloride	Rat	LOAEL	Liver toxicity	5.3	A
Tetrachloroethene	Mouse	LOAEL	Hepatotoxicity	7.1	A
Toluene	Rat	NOAEL	Liver, kidney, body weight	590	B
Trichloroethene	Rat	NOAEL	Maternal weight, neonatal survival	100	B

Table 2-3 (Continued)
Mammalian Oral TRVs

Chemical	Species	Endpoint	Effect	TRV (mg/kg-d)	Reference
Xylenes	Rat	NOAEL	Increased mortality	179	A
Other Organic Compounds					
Bis(2-ethylhexyl)phthalate	Guinea pig	LOAEL	Increased liver weight	1.9	A
Butylbenzylphthalate	Rat	NOAEL	Increased liver weight	250	A
Carbazole	Rat	LD_{50}	Mortality	5.0	I
Di-n-butylphthalate	Mouse	LOAEL	Reproductive/developmental toxicity	8.0	B
Di-n-octylphthalate	Rat	LOAEL	Increased fetal weight	30	B
Diethylphthalate	Rat	NOAEL	Decreased growth rate, altered organ weights	750	A
N-Nitrosodiphenylamine	Rat	LD_{50}	Mortality	16.5	I
Phenol	Mouse	NOAEL	Developmental toxicity	140	A
Metals					
Arsenic	Mouse	LOAEL	Decreased survival	0.038	B
Barium	Rat	NOAEL	None reported	31.5	A
Beryllium	Mouse	NOAEL	None reported	0.95	A
Cadmium	Rat	LOAEL	Depressed myocardial activity	0.025	B
Chromium	Rat	NOAEL	None reported	2.4	A
Cobalt	Rat	LOAEL	Degenerative lesions in seminiferous tubules	1.6	C
Copper	Rat	NOAEL	Altered enzyme metabolism, decreased body weight	67	B
Lead	Rat	LOAEL	Reduced survival and reproduction	0.5	D
Mercury	Mink	LOAEL	Poisoning; high brain residues	0.02	F

Table 2-3 (Continued)
Mammalian Oral TRVs

Chemical	Species	Endpoint	Effect	TRV (mg/kg-d)	Reference
Nickel	Rat	NOAEL	Decreased body and organ weights	5.0	B
Selenium	Rat	NOAEL	Reduced fetal weight, teratogenic effects	0.45	B
Silver	Rat	LOAEL	Ventricular hypertrophy, tissue pigmentation	10	E
Vanadium	Rat	LOAEL	Increased mortality	0.11	B

SOURCES:

A USEPA 1995
B CESARS 1994
C Puls 1989
D Eisler 1988b
E National Research Council (NRC) 1980
F Eisler 1987a
G RTECS 1993
H ATSDR 1990
I Sax, Lewis 1989
J Brown 1978
K ATSDR 1994c
L ATSDR 1994d
M Newell et al 1987

Table 2-4
Avian Oral Screening Levels TRVs

Chemical	Species	Endpoint	Effect	TRV (mg/kg-d)	Reference
Chlorinated Hydrocarbons					
1,4-Dichlorobenzene	Duck	LOAEL	Liver and kidney effects	50	A
Hexachlorobenzene	Quail	NOEL	Liver effects	0.2	L
Hexachlorobutadiene	Japanese quail	NOAEL	None reported	5	B
PCBs					
Aroclor 1248	Chicken	NOEL	Reproduction loss	0.22	L
Aroclor 1254	Chicken	LOAEL	Reproductive impairment	0.035	J
Aroclor 1260	Chicken	LOAEL	Reproductive impairment	0.035	J
Total PCBs	Screech owl	NOAEL	Reproduction	0.15	J
PAHs					
Acenaphthene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Anthracene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Benzo(a)anthracene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Benzo(a)pyrene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Benzo(b)fluoranthene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Benzo(g,h,i)perylene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Benzo(k)fluoranthene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Chrysene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Fluoranthene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Naphthalene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I

Table 2-4 (Continued)
Avian Oral Screening Level TRVs

Chemical	Species	Endpoint	Effect	TRV (mg/kg-d)	Reference
Phenanthrene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Pyrene	Mallard	LOAEL	Increased liver weight and blood flow to liver	20	I
Pesticides					
4,4'-DDD	Mallard	NOAEL	Reduced egg thickness, egg cracking, embryo mortality	0.5	K
4,4'-DDE	Mallard	NOAEL	Reduced egg thickness, egg cracking, embryo mortality	0.5	K
Total DDT	Brown pelican	NOEL	Reproductive impairment	0.2	L
	Bald eagle	NOEL	Mortality	0.3	L
Aldrin	Quail	NOEL	Increased mortality	2.5	L
Dieldrin	Chicken	NOEL	Decreased chick survival	0.035	L
Endrin	Screech owl	LOEL	Reduced number of young	0.004	L
Heptachlor epoxide	Chicken	NOEL	None reported	0.05	L
Metals					
Arsenic	Turkey	NOAEL	Recommended tolerance as arsanilic acid	5	C
Cadmium	Chicken	LOAEL	Decreased feeding, egg production	0.02	B
Chromium	Chicken	NOAEL	Survival; growth; food utilization	4.5	D
Copper	Chicken	NOAEL	Decreased weight gain	24.7	B
Lead	Mallard	NOEL	Survival, pathology	1.25	F
Mercury	Mallard	LOAEL	Egg-laying behavior; fewer eggs and ducklings	0.0005	H
Nickel	Chicken	NOAEL	Growth	6	G
Selenium	Mallard	NOAEL	Increased embryo abnormality, mortality	0.5	B

Table 2-4 (Continued)
Avian Oral Screening Level TRVs

Chemical	Species	Endpoint	Effect	TRV (mg/kg-d)	Reference
Silver	Chicken	NOAEL	None reported	1.75	E
Vanadium	Chicken	NOAEL	Decreased egg production	1.9	B
Zinc	Chicken	LOAEL	None reported	14	E

Sources:

A USEPA 1995
B CESARS 1992-1993
C Eisler 1988a
D Eisler 1986a
E Puls 1989
F Eisler 1988b
G National Research Council (NRC) 1980
H Eisler 1987a
I Eisler 1987b
J Eisler 1986b
K Brown 1978
L Newell et al. 1994

Professional judgement was employed to select TRVs from literature data, particularly with regard to evaluation of study design, endpoints, species, exposure route, and dose used in the study. While in general, NOAELs for significant adverse effects (e.g., mortality, reproductive effects) were used, in some cases the NOAELs were based on studies for less serious endpoints, while the published LOAELs were for more significant endpoints. In these cases, the LOAEL was used (with the application of an uncertainty factor of 0.1).

Most toxicological studies evaluate effects of a single contaminant on a single species under controlled laboratory conditions. Applying results from these studies to the field, where organisms typically are exposed to a mixture of contaminants in situations that are not comparable to a laboratory study, introduces a large uncertainty. In field situations, organisms may also be exposed to other environmental stressors, including diseases, food shortages, and unusual weather conditions. These "natural" stressors may have positive or negative effects on the organism's response to a toxic contaminant that only a site-specific field study can evaluate.

3.0 PRELIMINARY EXPOSURE ESTIMATE

3.1 Assumptions

This SLRA focuses on exposure to receptors from contaminants in Devil's Swamp through the ingestion of contaminated food, water, and sediments. Because relatively little site specific information currently exists on which to base the SLRA, a number of conservative assumptions were made regarding exposure. These assumptions generally involve residency of a species in the affected area, co-occurance of a species with contaminants, intake parameters for each species, absorption rates, and contaminant excretion and/or metabolic processes within the species evaluated. Preliminary exposure pathways were evaluated in Section 1.5.

In order to effectively determine if: 1) no significant risk is associated with the site, or 2) there is not enough information to determine whether or not risk is associated with the site, conservative exposure assumptions are developed which will not likely underestimate actual exposure. Although some assumptions may overestimate actual species-specific site exposures, it is neccesary to use such conservatism in the absence of more site-specific information. In light of the objective of this assessment, the following conservative exposure assumptions are used:

- Maximum concentrations of site contaminants reported observed in sediment, surface water, and food sources were assumed to be present site-wide, and represented concentrations to which the receptors would be exposed 100 percent of time;
- Receptors of concern reside and use the affected area throughout the year and over a lifetime, and are hence exposed to maximum concentrations 100 percent of the time;
- Intake parameters (such as body weight, dietary intake, sediment intake, and water intake) are as presented in Section 3.2;
- Contaminant uptake into gut equals 100 percent;
- For the purposes of evaluating biotransfer of contaminants, retention factors were developed as conservative assumptions to quantify predicted tissue concentration in contaminant-transfer organisms.

3.2 Quantification of Exposure

To estimate contaminant exposure for the representative receptor species, ingestion rates and dietary composition were obtained from the literature, or assumed.

Exposure parameters for the wetland shore bird (heron), raptor (eagle), and terrestrial nearshore carnivor (mink) were obtained from the "Wildlife Exposure Factors Handbook" (USEPA 1993i). Data were not available for the crawfish or pallid sturgeon, so assumed intake parameters were used. The "Wildlife Exposure Factors Handbook" presents a comprehensive and current catalogue of exposure factors for some of the receptors of concern. Table 3-1 presents a quantitative exposure profile of ingestion for each of the species evaluated.

In addition to exposure parameters, retention factors (Table 3-2) were developed to conservatively assess transfer of contaminants from the benthic invertabrates (crawfish) and fish (pallid sturgeon) to higher trophic levels (i.e., to the heron, bald eagle, and mink). The result of using assumed retention factors for different categories of chemicals is the ability to predict food concentrations for consumers of the organism evaluated. This approach allows an evalation of chemical exposure in higher trophic levels to chemicals analyzed only in select media. For example, available sediment data included many chemical analyses, while available biota data contained very few analyses. This data gap, and the resulting attempt at filling it through a modelling effort, introduce substantial uncertainty into the evaluation. However, because of the conservatism, Type II errors are likely minimized, and pursuit of the primary objective of this SLRA is maintained.

For this SLRA, limited information was available regarding bioconcentration factors (BCFs) and bioaccumulation factors (BAF), for most of the chemical contaminants in crawfish and benthic freshwater fish. In addition, most of the studies report BCFs based on water column flow-through tests. Therefore, to account for the sediment exposure pathway, conservative assumptions were used to predict tissue concentrations in the crawfish and benthic fish.

Total site contaminant intake for receptors of concern is calculated using the following equation:

$$Total\ intake = \frac{\sum_n^i C_n * I_n}{BW}$$

where:

Total Intake	=	(mg/kg/d)
$C_i..C_n$	=	Concentrations in various exposure media, including food sources, sediments, soils and water (mg/kg)

$I_i..I_n$ = Intakes of various exposure media, including food sources, sediments, soils and water (kg/d)

BW = Body weight of receptor (kg)

Table 3-1
Wildlife Intake Assumptions

Representative Species	Body Weight (kg)	Diet[a] (kg/d)	Food[b] (kg/d)	Sediment Ingestion (kg/d)	Water Ingestion (kg/d)
Crawfish[c]	0.01	0.0007	0.0006	0.0001	delete in model
Pallid Sturgeon[c]	2.0	0.19	0.14	0.047	delete in model
Bald Eagle[d]	3.5	0.48	0.46	0.024	0.1
Blue Heron[d]	2.0	0.4	0.36	0.04	0.09
Mink[d]	0.8	0.19	0.184	0.01	0.088

[a] Diet includes food (biota) intake, as well as as inadvertant sediment/soil ingestion
[b] Total food intake; dietary composition (i.e. specific food-type intakes) are presented in Appendix B
[c] Intakes were assumed due to the absence of species-specific exposure parameters
[d] Parameters were derived from USEPA (1993i)

In order to calculate predicted tissue concentrations in the crawfish and pallid sturgeon, the following equation was developed:

$$\textit{Predicted Tissue Concentration} = \textit{Total Intake} * D * RF$$

where:

Predicted Tissue Concentration	=	(mg/kg)
Total Intake	=	(mg/kg-d)
D	=	days exposed
RF	=	retention factor (unitless)

The number of days exposed equals an assumed time period before the animal was consumed by a higher order organism. The crawfish was assumed to be exposed for 90 days, and the pallid sturgeon for 365 days (1 year).

Table 3-2
Retention Factors

Chemical Group	Rentention Factor
Volatile Organic Compounds[a]	0.01
Chlorinated Benzenes[b]	0.1
PCBs[c]	1.0
PAHs[b]	0.1
Pesticides[c]	1.0
Other SVOCs[b]	0.1
Metals[a]	0.01

[a] Volatile organics and metals were assumed to have lower residency times (relative to other organics) in tissue because of water solubility and volatility
[b] Organics were assumed to be retained in tissues at a rate of 10 percent
[c] PCBs and Pesticides were assumed to be 100% retained

Total contaminant intake through ingestion is expressed in mg/kg of body weight per day (mg/kg-d). These units were chosen as a standard, although other units are commonly used.

Table 3-1 also lists the assumptions used to calculate water intake for the receptors of concern. Contaminant intake through water ingestion is calculated similarly to dietary intake, assuming an equivalency of liters to kilograms. Literature values for wildlife intake normally provide water intake in units of liters per day, or as a percentage of body weight. The density of Devil's Swamp water was assumed to be 1.0; hence an equivalency of liters to kilograms.

Water ingestion for the crawfish and pallid sturgeon were not evaluated. Presumably, sediment contaminant and water quality criteria are protective of aquatic organisms exposed (dermally and through gill respiration) to site contamination in water and sediments. Therefore, these exposure pathways for these receptors of concern are not evaluated in this modelling effort.

Intake calculations based on the model assumptions are presented in Appendix B. Intake levels are compared with effect levels (TRVs) in Section 4.0.

3.3 Exposure Uncertainty

The uncertainty in exposure characterization is derived primarily from modeling assumptions and data summaries used for modeling input. Animal intake modeling encompasses several assumptions including sediment/soil, food, and water intake, rate of absorption, as well as body weight and residence time. For the purposes of predicting food chain transfers, retention factors also introduce substantial uncertainty. Ranges of these parameters are researched in the literature, and when available, conservative ends of these ranges are selected as modeling assumptions. In addition, dynamic interactions are generally not well characterized for ecosystems and become a major source of uncertainty.

4.0 PRELIMINARY RISK CALCULATIONS

To estimate the potential risk to wildlife inhabiting Devil's Swamp, the exposure concentrations are compared to conservative screening level TRVs. The hazard quotient method (USEPA 1989) was used in this SLRA. The hazard quotient method compares exposure concentrations (doses) to ecological endpoints (TRVs) reported in the literature. The comparisons are expressed as the ratio of potential intake values to observed effects or no effects levels, as follows.

Species modeled for specific contaminant intake:

$$\textit{Hazard Quotient} = \frac{\textit{Contaminant Intake (Dose)}}{\textit{TRV}}$$

Species evaluated indirectly through media concentrations

$$\textit{Hazard Quotient} = \frac{\textit{Media Concentration}}{\textit{TRV}}$$

A hazard quotient greater than 1 indicates that exposure to the contaminant has the potential to cause adverse effects in the organism.

Exposure concentrations were calculated for each target receptor species based on concentrations of contaminants measured in site media and biota, and daily intake rates, as discussed in Section 3.

For the purposes of evaluating multiple contaminant exposure, it was conservatively assumed that simultaneous exposure would result in additive toxicity from each contaminant. To account for the additive toxicity of each contaminant, hazard indices (HI) were calculated for each species by adding the hazard quotients for all contaminants. HQs and HIs for each species or media evaluated are presented in Appendix C.

4.1 Hazard Quotient Analyses

Appendix Tables C-1 through C-5 provide a full listing of the calculated hazard quotients and hazard indices for surface water, sediments, and the representative species of concern: bald eagle, blue heron, and mink. Surface water and sediment hazard quotients are assumed to be applicable for indicating potential risks to various aquatic organisms, including crawfish and fish (e.g., pallid sturgeon). The following subsections summarize hazard quotients, cummulative hazard indices, and identify the largest potential contrubuters to overall hazards.

Surface Water - A total hazard index of 9,000 was calculated for surface water. The largest portion of the hazard was derived from mercury (HQ=8,900); other chemicals posing potential risks include lead (HQ=64), cadmium (HQ=13), and copper (HQ=1.5), as well as some pesticide and semivolatiles.

Sediments - A total hazard index of 5,000 was calculated for sediments. Most of the hazard was derived from 1,2,4-trichlorobenzene (HQ=4,200); other chemicals substantially contributing to potential risks include pesticicides and PCBs. Some PAHs and metals also had hazard quotients of greater than 1, but relative contributions to the overall hazard index from these groups were small.

Blue Heron - A total hazard index of 1,400 was calculated for the blue heron. Most of the hazard was derived from PCBs (HQ=460), hexachlorobenzene (HQ=320), and hexachlorobutadiene (HQ=210). Other chemicals substantially contributing to potential risks include metals such as mercury, cadmium, and lead. Pesticides and PAHs also had some hazard quotients of greater than 1, but relative contributions to the overall hazard index from these groups were small.

Bald Eagle - A total hazard index of 970 was calculated for the bald eagle. PCBs (HQ=380), hexachlorobenzene (HQ=250), and hexachlorobutadiene (HQ=160) were the dominant contributors. Other chemicals contributing to potential risks include some metals, pesticides, and PAHs.

Mink - A total hazard index of 6,100 was calculated for the mink. Again, PCBs (HQ=1,997), hexachlorobenzene (HQ=1,400), hexachlorobutadiene (HQ=600), and lead (HQ=1,000) were dominant. Other chemicals contributing to potential risks, but to a lesser degree, include various metals, pesticides, and PAHs.

Based on the above analysis, the potential for adverse effects exists in surface water, sediments, and each of the modeled surrogate organisms. The sediments appear to be the most contaminated medium due to the number of contaminants with HQs greater than one. The magnitude of HQs for each of the receptor organisms indicate that the potential for adverse effects is likely to be present throughout much of the food-web.

4.2 Uncertainty Analysis

The nature and extent of environmental chemicals of concern throughout Devil's Swamp and Bayou Baton Rouge is largely unknown. This SLRA relies on data that were collected at various times (both seasonally and annually), by public agencies and private contractors. It is unknown if any of the sampling and analysis planning was specifically designed for ecological risk assessment. This resulted in uncertainty such as:

- The lack of adequate spatial coverage;

- No direct measurements of biological indicators or environmental variables that would effect bioavailability;

- Consistency in sampling methodologies, quality assurance and control of the data; and

- Gross modeling assumptions.

These uncertainties combine to over-estimate risks for some compounds, but potentially under-estimate risk for others. The following discussion documents these areas of uncertainty.

4.2.1 Adequacy/Accuracy of Analytical Data and Spatial Coverage

An important uncertainty is the adequacy and accuracy of the analytical data. This SLRA represents a compilation of data collected by LDEQ, PRC, and NPC. Inconsistency in sample techniques, documentation, variable data collection methods, species selected for tissue analysis, and limited lists of analytes in biological tissues, all seriously compromise the integrity, and hence utility, of the data used for assessing risk.

Spacial coverage of sediment, water, and tissue measurements of contaminants are not sufficient to adequately characterize environmental risk at the site. Sample locations were bias-selected in the field toward locating hot spots. While these data are useful for that purpose, as well as to document suspicion of risk, they are not representative of the 18 km^2 area of concern. In general, biased sampling results in an over-estimation of environmental risk. Areas further away from contaminant sources are less likely to show appreciable concentrations, especially for volatile organic compounds such as hexachlorobenzene. On the other hand, while there are numerous samples collected nearshore of the principal industries of concern in upper Bayou Baton Rouge and Northern Devil's Swamp, there are no data reported from Brooks Lake (northwest of Devil's Swamp), even though there is documented flow from Bayou Baton Rouge into the lake (PRC 1993a). Lack of data in some areas may under-represent environmental risk.

While the current data consists of 102 sediment samples (collected from variable and inconsistent depths), there are only 15 water samples, and fewer biological tissue samples. These data (especially water and tissue) are unlikely to provide quantification of risks with sufficient level of confidence. In addition, conventional water quality (e.g., hardness, total suspended solids) and sediment parameters (e.g., total organic carbon, acid volatile sulfide) were not obtained, making toxicological interpretations difficult.

Probably the largest source of uncertainty associated with the analytical data is the lack of consistent quality assurance/quality control (QA/QC) procedures. The program sampling objectives, or data quality objectives (DQOs) from each of the multiple sampling events by PRC and NPC Services, Inc., were often different or inconsistent. QA/QC procedures have been formalized to establish a means for obtaining precise, legally-defensible data that can be used for risk-management decision making. These are lacking with respect to the current data set.

Some of the Contract Laboratory Program (CLP) detection limits for some compounds are too high to adequately characterize ecological risk. High detection limits introduce uncertainty in under-estimating or not accounting for environmental risk at lower concentrations. This is especially true for the nonpolar organic compounds that bioaccumulate. For example, the detection limits for 4,4'DDT in sediment and water is reported at 3.3 mg/kg and 0.1 mg/L, respectively. Yet the sediment TRV is 2.2 mg/kg, and has been reported to have food-chain magnification potential in water in picogram concentrations (USEPA 1993a). Likewise, the chronic water quality criterion for endrin is 0.0023 μg/L, but the CLP detection limit used in previous work is only 0.1 μg/L; two orders of magnitude higher.

Considerable uncertainty is introduced into the risk assessment due to lack of site-specific information on environmental variability (stochasticity). For example, seasonal flooding conditions can effect chemical bioavailability, sedimentation capping of contaminants, or resuspension of contaminated sediment. There are seasonal changes in sediment redox potential, sediment organic carbon, and acid volatile sulfides. Each of these factors have the potential to affect bioavailability of contaminants. Biological species presence/activities, food chains, and reproductive cycles are all seasonally influenced. Risk to aquatic, and terrestrial species will not be uniform year-round. Such data are currently lacking and it is neither practical nor desirable to extrapolate from existing data to account for these effects.

Furthermore, there are multiple habitat sites represented within Devil's Swamp; ranging from open water to intermittantly hydrated swamp forest. Each of these habitats represent unique environs, and unique exposure pathways. This SLRA uses single point maximum values to assess risk for all habitats. While adequate for screening the site, risk is likely to be overestimated for the entire 18km^2 site using maximum values.

4.2.2 Biological Effects Data

Uncertainty in this SLRA is increased by the lack of direct measurements of the effects on resident biota. Ecological risk to multiple trophic levels can be estimated using analytical data, biomagnification transfer modeling, and comparison of the modeled results to TRVs, as has been done in this SLRA. However, this methodology introduces uncertainty through lack of information on site-specific effects, effects on resident species, or through gross modeling assumptions. The Devil's Swamp ecosystem is very complicated with numerous physical, chemical, and biological processes that affect ecotoxicity. TRVs are often extrapolated from other species to the receptors of concern. For example, use of TRVs developed for chickens or rats may have no relationship to actual effects on herons or minks at the site. In addition, chemical speciation is normally assumed to be in the most toxic form, increasing the chance for overestimation of adverse effects. As can be seen from Appendix Tables C-1 through C-5, a significant proportion of the TRVs were unavailable.

Biological effects are often evaluated through bioassays, assessment of communities (e.g., sediment infaunal analyses), bioaccumulation studies and/or direct tissue residue measurements on resident species. The only information available for this SLRA are limited data on levels of some contaminants in a few resident organisms (species unknown). The same concerns on seasonality, spatial distribution, and QA/QC apply to the analytical results of tissue residue values.

4.2.3 Modeling Uncertainty

The biomagnification model and assumptions employed to assess food-web bioaccumulation risks are, at best, order-of-magnitude estimates. However, the model used for this SLRA is a static model that has as a first order assumption, ingestion equals bioaccumulation. The model does not address important issues such as: 1) bioavailability of contaminants in sediment due to equilibrium partitioning for organics or acid-volatile sulfides for metals, 2) bioconcentration of dissolved contaminants through gills of fish or invertebrates, 3) the kinetics of bioaccumulation such as metabolic degradation of contaminants and/or excretion rates, and 4) the lipidophilic tendencies and maximum accumulation levels for some contaminants. The model employed in this SLRA will tend to overestimate accumulation of some chemicals (e.g., metals, PAHs) and potentially under-estimate non-polar organics (e.g., DDT, endrin).

In addition to the uncertainty associated with the model employed, the application assumptions also introduce considerable uncertainty. For example, using the maximum concentration found in sediments and water, assuming year-round exposure to contaminants, applying assumed (non-scientifically derived) retention factors, all contribute to a general lack of confidence in the modeling results for risk management purposes.

Uncertainties associated with the TRVs and hazard quotients are not necessarily reflective of chemical mixtures. Although an additive approach of HQs was assumed for this SLRA, there is very limited information on the toxicity of simultaneous exposure to mixtures of contaminants. For example, whether simultaneous exposure to HCB, HCBD, and PCB is additive in nature is unknown. This uncertainty also affects confidence in the hazard indices.

5.0 SUMMARY

This SLRA was developed to provide information for risk managers to decide if the site preliminary screening is adequate to determine either: 1) that there is little or no ecological threat, or 2) the information is not adequate to evaluate risk to potential ecological receptors.

The uncertainty inherent in this preliminary risk assessment step (refer to Figure I) is biased conservatively in the evaluation of exposure, site-specific contamination, and selection of literature-based measurement endpoints. Other conservative assumptions have been used throughout the SLRA. Therefore, cleanup decisions based solely on the information presented in this SLRA would not be technically defensible.

The preliminary problem formulation (Section 1) addressed the environmental setting; existing contamination; contaminant fate and transport mechanisms that may exist at the site; toxic mechanisms of contaminants; categories of receptors likely to be affected; and, an initial evaluation of exposure pathways.

A preliminary evaluation of the ecological effects associated with the detected contaminants (Section 2) was conducted to evaluate the likelihood of toxic effects to biota. Because 92 potential contaminants were detected within the site, the toxic mechanisms of contaminant groups and selected specific hazardous chemicals were discussed. A literature review was also conducted to compile a list of preliminary toxicological reference values relevant to likely receptor categories.

Based on a review of the issues presented in the initial problem formulation section combined with the preliminary ecological effects data, conservative assumptions were developed for those complete exposure pathways to selected representative receptors (Section 3). The following basic exposure pathways were determined to be complete: 1) aquatic organisms exposed to surface water, 2) benthic organisms, including crawfish, exposed to sediments, 3) contaminant transfer to other trophic levels (waterfowl, raptors, and mammals) via ingestion of prey and sediments.

Preliminary risk calculations were performed in Section 4, along with an analysis of hazard quotients. The potential for adverse effect was considered likely for those hazardous chemicals that had hazard quotients greater than one. The maximum contaminant concentration in surface water and sediments were compared to toxicological reference values such as aquatic life criteria and sediment effects levels derived from the literature. To assess the potential risk from biotransfers of contaminants through the food web, results from the simplified intake and biotransfer models for the selected receptors were compared to TRVs.

Hazard quotients greater than one were found for numerous contaminants in each media (i.e., surface water, sediments, and in selected receptors). Based only on the magnitude of the HQs, several contaminants consistently indicate the potential for adverse risk. These include hexachlorobenzene, hexachlorobutadiene, PCBs, and mercury. However, the contaminant mixtures in each media resulted in overall hazard indices that were greater than 1,000. The major uncertainties associated with this SLRA were also presented in Section 4.

Based on the limited information available for this SLRA, it appears that contaminants in Devil's Swamp and Bayou Baton Rouge could be posing adverse effects to biota utilizing the site.

A detailed analysis of ecosystem structure and function, coupled with a more thorough evaluation of site contamination will allow for a more comprehensive problem formulation. This will allow for the development of specific assessment and measurement endpoints which should provide a plan for gathering necessary site information so that a technically defensible risk assessment can be constructed.

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APPENDIX A

DATA SUMMARY REPORTS

87489-002

Table A-1
Data Summary Report for Sediments in Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Detection Limit	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Location of Maximum
Volatile Organic Compounds							
1,1,1 - Trichloroethane	1	102	0.98	0.010	0.003	0.003	DS-SS-22
1,1,2,2, Tetrachloroethane	9	102	8.82	0.010	0.001	33.000	DS-SS-28
1,1,2 - Trichloroethane	3	102	2.94	0.010	0.003	4.100	DS-SS-28
1,1 - Dichloroethane	1	102	0.98	0.010	0.009	0.009	BBR-SS-12
1,2 - Dichloroethane	7	102	6.86	0.010	0.001	0.990	BBR-SS-10
1,2 - Dichlordethene (total)	2	102	1.96	0.010	0.390	1.100	BBR-SS-10
1,2 - Dichloropropane	1	102	0.98	0.010	2.500	2.500	BBR-SS-10
2-Butanone	33	102	32.35	0.010	0.003	0.120	DS-SS-16
Acetone	42	102	41.18	0.010	0.004	14.000	DS-SS-28
Benzene	4	102	3.92	0.010	0.002	0.200	BBR-SS-10
Carbon Disulfide	3	102	2.94	0.010	0.003	1.500	BBR-SS-10
Chloroform	2	102	1.96	0.010	0.002	0.002	DSL-SS-09, DSL-SS-17
Ethylbenzene	7	102	6.86	0.010	0.002	1.800	DSL-SS-20
Methylene Chloride	26	102	25.49	0.010	0.000	0.390	DS-SS-16
Tetrachloroethene	5	102	4.90	0.010	0.006	220.000	DS-SS-28, DS-SS-31
Toluene	20	102	19.61	0.010	0.002	4.400	DS-SS-28

87489-003

Table A-1 (Continued)
Data Summary Report for Sediments in Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Detection Limit	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Location of Maximum
Trichloroethene	5	102	4.90	0.010	0.002	40.000	DS-SS-32, DS-SS-28
Vinyl Chloride	1	102	0.98	0.010	0.280	0.280	BBR-SS-12
Xylenes (total)	9	102	8.82	0.010	0.002	0.310	DSL-SS-20
Chlorinated Benzenes							
1,2,4 - Trichlorobenzene	7	102	6.86	0.330	0.058	84.000	DS-SS-31
1,2 - Dichlorobenzene	12	102	11.76	0.330	0.027	3.600	DS-SS-31
1,3 - Dichlorobenzene	16	102	15.69	0.330	0.036	8.300	DS-SS-31
1,4 - Dichlorobenzene	20	102	19.61	0.330	0.052	8.300	DS-SS-31
Chlorobenzene	16	102	15.69	0.010	0.005	2.300	DS-SS-33
Hexachlorobenzene	28	102	27.45	0.330	0.079	470.000	DS-SS-31
PAHs							
2 -Methylnaphthalene	12	102	11.76	0.330	0.037	13.000	DS-SS-31
Acenaphthene	14	102	13.73	0.330	0.053	2.500	DS-SS-28
Acenaphthylene	11	102	10.78	0.330	0.085	1.100	DSL-SS-20
Anthracene	19	102	18.63	0.330	0.036	2.300	DSL-SS-20
Benzo(a)anthracene	29	102	28.43	0.330	0.031	3.000	DSL-SS-20
Benzo(a)pyrene	31	102	30.39	0.330	0.023	0.560	DSL-SS-15, DSL-SS-16
Benzo(b)fluoranthene	20	102	19.61	0.330	0.038	0.740	DSL-SS-16

87489-004

Table A-1 (Continued)
Data Summary Report for Sediments in Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Detection Limit	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Location of Maximum
Benzo(g,h,i) perylene	3	102	2.94	0.330	0.033	0.073	DS-SS-20
Benzo(k)fluoranthene	12	102	11.76	0.330	0.040	0.740	DSL-SS-16
Chrysene	33	102	32.35	0.330	0.031	4.000	DS-SS-31
Fluoranthene	42	102	41.18	0.330	0.025	7.500	DS-SS-31
Fluorene	18	102	17.65	0.330	0.051	13.000	DS-SS-31
Naphthalene	10	102	9.80	0.330	0.037	50.000	DS-SS-28
Phenanthrene	45	102	44.12	0.330	0.026	340.000	DS-SS-31
Pyrene	47	102	46.08	0.330	0.033	10.000	DS-SS-31
Phenolics							
4 - Chloro-3-Methylphenol	1	102	0.98	0.330	0.100	0.100	DSL-SS-11
Phenol	2	102	1.96	0.330	0.068	0.097	DSL-SS-11
Phthalate Esters							
Bis(2-ethylhexyl)phthalate	60	102	58.82	0.330	0.035	5.900	DSL-SS-20
Butylbenzylphthalate	10	102	9.80	0.330	0.058	1.000	DSL-SS-16
Di-n-butylphthalate	8	102	7.84	0.330	0.041	1.900	DS-SS-28
Di-n-octylphthalate	9	102	8.82	0.330	0.050	12.000	DSL-SS-16, DSL-SS-20
Diethylphthalate	1	102	0.98	0.330	0.460	0.460	BBR-SS-01

87489-005

Table A-1 (Continued)
Data Summary Report for Sediments in
Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Detection Limit	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Location of Maximum
Other SVOCs							
3,3'-Dichlorobenzidine	1	102	0.98	0.330	0.240	0.240	DSL-SS 12
Carbazole	2	102	1.96	0.330	0.075	0.076	DSL-SS-13
Hexachlorobutadiene	15	102	14.71	0.330	0.190	12,000	DS-SS-32
Hexachloroethane	3	102	2.94	0.330	76.000	110	DS-SS-32
N-nitrosodiphenylamine	16	102	15.69	0.330	0.054	13	DSL-SS-20
PCBs							
Aroclor-1248	12	102	11.76	0.033	0.052	5.2	DSL-SS-16
Aroclor - 1254	39	102	38.24	0.033	0.009	6.4	DSL-SS-16
Aroclor-1260	10	102	9.80	0.033	0.021	3	DSL-SS-21
Pesticides							
4,4'-DDD	6	102	5.88	0.0033	0.00031	0.0160	DSL-SS-21
4,4'-DDE	15	102	14.71	0.0033	0.00031	0.0190	DSL-SS-21
Aldrin	5	102	4.90	0.0017	0.00012	0.6100	BBR-SS-12
Alpha-BHC	8	102	7.84	0.0017	0.00013	0.0036	DSL-SS-26
Alpha-Chlordane	14	102	13.73	0.0017	0.00085	0.0510	DSL-SS-21
Beta-BHC	5	102	4.90	0.0017	0.00039	0.0038	DSL-SS-11
Delta-BHC	8	102	7.84	0.0017	0.00015	0.0020	DSL-SS-08
Dieldrin	1	102	0.98	0.0033	0.00028	0.00028	DSL-SS-01

Table A-1 (Continued)
Data Summary Report for Sediments in Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Detection Limit	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Location of Maximum
Endosulfan I	13	102	12.75	0.0017	0.00090	0.2300	DS-SS-18
Endosulfan II	4	102	3.92	0.0033	0.00040	0.0200	BBR-SS-12
Endosulfan Sulfate	14	102	13.73	0.0033	0.00017	0.0054	DSL-SS-22
Endrin	3	102	2.94	0.0033	0.00075	0.0022	DSL-SS-01
Endrin Aldehyde	12	102	11.76	0.0033	0.00082	0.0150	DSL-SS-13
Endrin Ketone	8	102	7.84	0.0033	0.00018	0.0071	DSL-SS-18
Gamma-BHC (Lindane)	3	102	2.94	0.0017	0.00015	0.0065	DSL-SS-26
Gamma-Chlordane	16	102	15.69	0.0017	0.00019	0.0110	DSL-SS-11
Heptachlor Epoxide	7	102	6.86	0.0017	0.00025	0.1700	BBR-SS-12
Methoxychlor	8	102	7.84	0.0170	0.00058	0.0670	DSL-SS-15
Metals							
Aluminum	88	102	86.27	40.00	559.00	36100.00	
Arsenic	88	102	86.27	2.00	0.73	618.00	BBR-SS-02
Barium	88	102	86.27	40.00	28.70	1210.00	BBR-SS-02
Berylluim	63	102	61.76	1.00	0.28	2.40	DS-SS-03, DS-SS-10
Cadmium	55	102	53.92	1.00	0.89	62.30	DS-SS-32
Chromium	88	102	86.27	2.00	0.00	94.80	DS-SS-01
Cobalt	87	102	85.29	10.00	1.70	113.00	BBR-SS-02
Copper	88	102	86.27	5.00	2.40	929.00	BBR-SS-02

87489-007

Table A-1 (Continued)
Data Summary Report for Sediments in Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Detection Limit	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Location of Maximum
Iron	88	102	86.27	20.00	1930.00	49000.00	BBR-SS 02
Lead	87	102	85.29	0.60	3.30	1410.00	BBR-SS-02
Magnesium	88	102	86.27	1000.00	83.60	8690.00	DS-SS-03
Manganese	88	102	86.27	3.00	65.90	1870.00	DSL-SS-26
Mercury	11	102	10.78	0.10	0.16	0.65	DSL-SS-29
Nickel	71	102	69.61	8.00	3.30	140.00	DSL-SS-20
Potassium	66	102	64.71	1000.00	318.00	3870.00	DSL-SS-14
Selenium	5	102	4.90	1.00	0.65	.92	DS-SS-20
Silver	17	102	16.67	2.00	1.60	11.80	DS-SS-14
Vanadium	88	102	86.27	10.00	3.80	82.00	DS-SS-03
Zinc	88	102	86.27	4.00	3.90	1820.00	BBR-SS-02

87489-008

Table A-2
Data Summary Report for Surface Water
Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Detection Limit	Minimum Conc. (mg/L)	Maximum Conc. (mg/L)	Location of Maximum
Volatile Organic Compounds							
1,1,2,2-Tetrachloroethane	2	15	13.33	10	0.017	0.017	BBR-SW-02, BBR-SW-03
1,1,2,-Trichloroethane	3	15	20	10	0.002	0.150	BBB-SW-03
1,1-Dichloroethene	1	15	6.67	10	0.006	0.006	BBR-SW-02
1,2-Dichloroethane	3	15	20	10	0.002	0.380	BBR-SW-03
1,2-Dichloroethene	1	15	6.67	10	0.078	0.078	BBR-SW-03
1,2-Dichloroethene (total)	1	15	6.67	10	0.076	0.076	BBR-SW-02
1,2-Dichloropropane	2	15	13.33	10	0.130	0.140	BBR-SW-03
2-Butanone	1	15	6.67	10	0.030	0.030	BBR-SW-02
Acetone	1	15	6.67	10	0.066	0.066	BBR-SW-02
Methylene Chloride	2	15	13.33	10	0.008	0.009	BBR-SW-02
Tetrachloroethene	2	15	13.33	10	0.007	0.008	BBR-SW-02
Toluene	3	15	20	10	0.008	0.01	NPDES-11
Trichloroethene	3	15	20	10	0.025	0.032	BBR-SW-02
Vinyl Chloride	2	15	13.33	10	0.057	0.060	BBR-DE-03
Xylenes (total)	2	15	13.33	10	0.001	0.003	DS-SW-02x
PAHs							
2-Methylnaphthalene	1	15	6.67	10	0.003	0.003	DS-SW-02x

Table A-2 (Continued)
Data Summary Report for Surface Water
Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Detection Limit	Minimum Conc. (mg/L)	Maximum Conc. (mg/L)	Location of Maximum
Naphthalene	1	15	6.67	10	0.003	0.003	DS-SW-02x
Phthalate Esters							
Bis(2-ethylhexyl)phthalate	4	15	26.67	10	0.0007	0.0010	BBR-SW-01
Di-n-butylphthalate	1	15	6.67	10	0.0010	0.0010	DSL-SW-04
Other SVOCs							
Hexachlorobutadiene	1	15	6.67	10	0.074	0.074	DS-SW-02x
N-nitrosodiphenylamine	1	15	6.67	10	0.004	0.004	DS-SW-02x
Pesticides							
Beta-BHC	2	15	13.33	0.05	0.000007	0.000009	DSL-SW-04
Endrin	1	15	6.67	0.1	0.000004	0.000004	DSL-SW-04
Heptachlor Epoxide	2	15	13.33	0.05	0.000002	0.000002	DSL-SW-02
Metals							
Aluminum	11	15	73.33	0.200	0.348	3.480	DS-SW-01
Bariym	11	15	73.33	0.200	0.0607	0.121	DS-SW-01
Cadmium	1	15	6.67	0.005	0.0086	0.8600	BBR-SW-01
Chromium	3	15	20	0.010	0.0043	0.0045	DSL-SW-01
Copper	4	15	26.67	0.025	0.0064	0.0095	DS-SW-02x
Iron	11	15	73.33	0.100	.855	3.2800	DS-SW-01
Lead	8	15	53.33	0.003	0.0058	0.0829	BBR-SW-01

87489-010

Table A-2 (Continued)
Data Summary Report for Surface Water
Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Detection Limit	Minimum Conc. (mg/L)	Maximum Conc. (mg/L)	Location of Maximum
Magnesium	11	15	73.33	5.000	4.78	7.86	BBR-SW-02, BBR-SW-03
Manganese	11	15	73.33	0.015	0.0973	1.69	BBR-SW-02
Mercury	5	15	33.33	0.0002	0.00034	0.107	BBR-SW-02
Potassium	11	15	73.33	5.0	3.29	10.30	DSL-SW-04
Selenium	3	15	20	0.005	0.0011	0.0022	DSL-SW-04
Vanadium	6	15	40	0.050	0.0077	0.0273	BBR-SW-01

Table A-3
Data Sumamry Report for Fish (Pelagic Whole) in Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Conc. (mg/kg)	Maximun Conc. (mg/kg)	Location of Maximum
Chlorinated Benzenes						
Hexachlorobenzene	12	12	100	0.00430	0.432	NPC-B9
Other SVOCS						
Hexachlorobutadiene	12	12	100.00	0.00327	2.020	NPC-B10
Metals						
Chromium	7	12	58.33	0.96	2.00	NPC-S26
Copper	3	12	25.00	0.90	49.50	NPC-S26
Mercuty	8	12	66.67	0.08	0.33	NPC-S11
Selenium	6	12	50.00	0.50	0.85	NPC-S29
Zinc	12	12	100.00	12.80	33.70	NPC-S2

87489-012

Table A-4
Data Summary Report for Fish (Pelagic Fillet)
Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Location of Maximum
Chlorinated Benzenes						
Hexachlorobenzene	11	12	91.67	0.0175	0.54	NPC-s11
Other SVOCS						
Hexachlorobutadiene	11	12	91.67	0.0112	1.18	NPC-B10
Metals						
Chromium	5	12	41.67	1.00	1.50	NPC-S29
Copper	5	12	41.67	1.50	40.10	NPC-S29
Lead	1	12	8.33	3.90	3.90	NPC-S24
Mercury	9	12	75	0.03	0.60	NPC-S24
Selenium	1	12	8.33	0.59	0.59	NPC-B10
Zinc	12	12	100	2.60	29.40	NPC-B10

87489-013

Table A-5
Data Summary Report for Fish (Benthic Fillet)
Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Location of Maximum
Chlorinated Benzenes						
Hexachlorobenzene	11	12	91.67	0.00404	0.822	
Other SVOCS						
Hexachlorobutadiene	12	12	100	0.00462	3.600	
Metals						
Chromium	1	12	8.33	0.95	0.95	NPC-S11
Copper	6	12	50	1.00	3.00	NPC-S9
Mercury	10	12	83.33	0.07	0.27	NPC-S9
Selenium	1	12	8.33	0.45	0.45	NPC-B10
Zinc	12	12	100	3.90	22.30	NPC-B10

87489-014

Table A-6
Data Summary Report for Mollusk
Devil's Swamp/Bayou Baton Rouge

Name	Detected	Total Sample	Percentage	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Location of Maximum)
Chlorinated Benzenes						
Hexachlorobenzene	9	9	100.00	0.0108	0.373	NPC-B9
Other SVOCS						
Hexachlorobutadiene	9	9	100.00	0.0120	0.597	NPC-B5
Metals						
Arsenic	5	9	55.56	0.560	0.690	NPC-B9
Cadmium	9	9	100.00	0.690	8.600	NPC-B1, NPC-B1
Chromium	6	9	66.67	0.770	1.300	NPC-B9
Copper	9	9	100.00	1.600	9.200	NPC-B1
Lead	1	9	11.11	1.700	1.700	NPC-B1
Mercury	2	9	22.22	0.020	0.040	NPC-B5
Selenium	1	9	11.11	0.550	0.550	NPC-B1
Zinc	9	9	100.00	22.700	45.200	NPC-B1

Table A-7
Data Summary Report for Raccoon
Devil's Swamp/Bayou Baton Rouge

87489-015

Name	Detected	Total Sample	Percentage	Minimum Conc. (mg/kg)	Maximum Conc. (mg/kg)	Location of Maximum
Chlorinated Benzenes						
Hexachlorobenzene	7	9	77.78	0.00897	0.0570	NPC-B9
Other SVOCS						
Hexachlorobutadiene	7	9	77.78	0.00279	0.0556	NPC-B5
Metals						
Chromium	2	9	22.22	1.100	1.800	NPC-B1
Copper	7	9	77.78	0.990	53.100	NPC-B1
Mercury	5	9	55.56	0.029	0.110	NPC-S12
Zinc	7	9	77.78	36.700	45.600	NPC-B10

APPENDIX B

CALCULATIONS OF CONTAMINANT INTAKES

Table B-1
Calculations of Contaminant Intake for the Crawfish

Chemical	Exposure Media Concentrations (mg/kg)					Intake Factor (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (90 days) (mg/kg)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)						
			Mollusk	Benthic Fish	Pelagic Fish			Mollusk	Benthic Fish	Pelagic Fish				
Volatile Organic Analytes														
1,1,1 - Trichloroethane		0.003					0.000106	0.0004	0.0001	0.0001	0.01	0.00003	0.01	0.000029
1,1,2,2, Tetrachloroethane	0.017	33					0.000106	0.0004	0.0001	0.0001	0.01	0.349412	0.01	0.314471
1,1,2 - Trichloroethane	0.15	4.1					0.000106	0.0004	0.0001	0.0001	0.01	0.043412	0.01	0.039071
1,1 - Dichloroethane	0.006	0.009					0.000106	0.0004	0.0001	0.0001	0.01	0.000095	0.01	0.000086
1,2 - Dichloroethane	0.38	0.99					0.000106	0.0004	0.0001	0.0001	0.01	0.010482	0.01	0.009434
1,2 - Dichloroethene (Total)	0.078	1.1					0.000106	0.0004	0.0001	0.0001	0.01	0.011647	0.01	0.010482
1,2 - Dichloropropane	0.14	2.5					0.000106	0.0004	0.0001	0.0001	0.01	0.026471	0.01	0.023824
2-Butanone	0.03	0.12					0.000106	0.0004	0.0001	0.0001	0.01	0.001271	0.01	0.001144
Acetone	0.066	14					0.000106	0.0004	0.0001	0.0001	0.01	0.148235	0.01	0.133412
Benzene		0.2					0.000106	0.0004	0.0001	0.0001	0.01	0.002118	0.01	0.001906
Carbon disulfide		1.5					0.000106	0.0004	0.0001	0.0001	0.01	0.015882	0.01	0.014294
Chloroform		0.002					0.000106	0.0004	0.0001	0.0001	0.01	0.00002	0.01	0.000019
Ethylbenzene		1.8					0.000106	0.0004	0.0001	0.0001	0.01	0.019059	0.01	0.017153
Ethylene chloride	0.009	0.39					0.000106	0.0004	0.0001	0.0001	0.01	0.004129	0.01	0.003716
Tetrachloroethene	0.008	220					0.000106	0.0004	0.0001	0.0001	0.01	2.329412	0.01	2.096471
Toluene	0.01	4.4					0.000106	0.0004	0.0001	0.0001	0.01	0.046588	0.01	0.041929
Trichloroethene	0.032	40					0.000106	0.0004	0.0001	0.0001	0.01	0.423529	0.01	0.381176
Vinyl chloride	0.06	0.28					0.000106	0.0004	0.0001	0.0001	0.01	0.002965	0.01	0.002668
Xylenes (Total)	0.003	0.31					0.000106	0.0004	0.0001	0.0001	0.01	0.003282	0.01	0.002954

Table B-1
Calculations of Contaminant Intake for the Crawfish
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Intake Factor (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (90 days) (mg/kg)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)						
			Mollusk	Benthic Fish	Pelagic Fish			Mollusk	Benthic Fish	Pelagic Fish				
Chlorinated Benzenes														
1,2,4 -Trichlorobenzene		84					0.000106	0.0004	0.0001	0.0001	0.01	0.889412	0.1	8.004706
1,2 - Dichlorobenzene		3.6					0.000106	0.0004	0.0001	0.0001	0.01	0.038118	0.1	0.343059
1,3 - Dichlorobenzene		8.3					0.000106	0.0004	0.0001	0.0001	0.01	0.087882	0.1	0.790941
1,4 - Dichlorobenzene		8.3					0.000106	0.0004	0.0001	0.0001	0.01	0.087882	0.1	0.790941
Chlorobenzene		2.3					0.000106	0.0004	0.0001	0.0001	0.01	0.024353	0.1	0.219176
Hexachlorobenzene		470	0.373	0.822	0.54		0.000106	0.0004	0.0001	0.0001	0.01	5.005011	0.1	45.0451
PAHs														
2 -Methylnaphthalene	0.003	13					0.000106	0.0004	0.0001	0.0001	0.01	0.137647	0.1	1.238824
Acenaphthene		2.5					0.000106	0.0004	0.0001	0.0001	0.01	0.026471	0.1	0.238235
Acenaphthylene		1.1					0.000106	0.0004	0.0001	0.0001	0.01	0.011647	0.1	0.104824
Anthracene		2.3					0.000106	0.0004	0.0001	0.0001	0.01	0.024353	0.1	0.219176
Benzo(a)anthracene		3					0.000106	0.0004	0.0001	0.0001	0.01	0.031765	0.1	0.285882
Benzo(a)pyrene		0.56					0.000106	0.0004	0.0001	0.0001	0.01	0.005929	0.1	0.053365
Benzo(b)fluoranthene		0.74					0.000106	0.0004	0.0001	0.0001	0.01	0.007835	0.1	0.070518
Benzo(g,h,i) perylene		0.073					0.000106	0.0004	0.0001	0.0001	0.01	0.000773	0.1	0.006956
Benzo(k)fluoranthene		0.74					0.000106	0.0004	0.0001	0.0001	0.01	0.007835	0.1	0.070518
Chrysene		4					0.000106	0.0004	0.0001	0.0001	0.01	0.042353	0.1	0.381176
Fluoranthene		3					0.000106	0.0004	0.0001	0.0001	0.01	0.031765	0.1	0.285882

Table B-1
Calculations of Contaminant Intake for the Crawfish
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Intake Factor (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (90 days) (mg/kg)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)						
			Mollusk	Benthic Fish	Pelagic Fish			Mollusk	Benthic Fish	Pelagic Fish				
Fluorene		13					0.000106	0.0004	0.0001	0.0001	0.01	0.137647	0.1	1.238824
Naphthalene	0.003	50					0.000106	0.0004	0.0001	0.0001	0.01	0.529412	0.1	4.764706
Phenanthrene		340					0.000106	0.0004	0.0001	0.0001	0.01	3.6	0.1	32.4
Pyrene		10					0.000106	0.0004	0.0001	0.0001	0.01	0.105882	0.1	0.952941
Phenolics														
4 - Chloro-3-methylphenol		0.1					0.000106	0.0004	0.0001	0.0001	0.01	0.001059	0.1	0.009529
Phenol		0.097					0.000106	0.0004	0.0001	0.0001	0.01	0.001027	0.1	0.009244
Phthalate Esters														
Bis(2-ethylhexyl)phthalate	0.001	5.9					0.000106	0.0004	0.0001	0.0001	0.01	0.062471	0.1	0.562235
Butylbenzylphthalate		1					0.000106	0.0004	0.0001	0.0001	0.01	0.010588	0.1	0.095294
Di-n-butylphthalate	0.001	1.9					0.000106	0.0004	0.0001	0.0001	0.01	0.020118	0.1	0.181059
Di-n-octylphthalate		12					0.000106	0.0004	0.0001	0.0001	0.01	0.127059	0.1	1.143529
Diethylphthalate		0.46					0.000106	0.0004	0.0001	0.0001	0.01	0.004871	0.1	0.043835
Other SVOCs														
3,3'-Dichlorobenzidine		0.24					0.000106	0.0004	0.0001	0.0001	0.01	0.002541	0.1	0.022871
Carbazole		0.076					0.000106	0.0004	0.0001	0.0001	0.01	0.000805	0.1	0.007242
Hexachlorobutadiene	0.074	12000	0.597	3.6	2.02		0.000106	0.0004	0.0001	0.0001	0.01	127.1389	0.1	1144.25
Hexachloroethane		110					0.000106	0.0004	0.0001	0.0001	0.01	1.164706	0.1	10.48235
N-nitrosodiphenylamine	0.004	13					0.000106	0.0004	0.0001	0.0001	0.01	0.137647	0.1	1.238824

Table B-1
Calculations of Contaminant Intake for the Crawfish
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Intake Factor (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (90 days) (mg/kg)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)						
			Mollusk	Benthic Fish	Pelagic Fish			Mollusk	Benthic Fish	Pelagic Fish				
PCBs														
Aroclor-1248		5.2					0.000106	0.0004	0.0001	0.0001	0.01	0.055059	1	4.955294
Aroclor-1254		6.4					0.000106	0.0004	0.0001	0.0001	0.01	0.067765	1	6.098824
Aroclor-1260		3					0.000106	0.0004	0.0001	0.0001	0.01	0.031765	1	2.858824
Pesticides														
4,4'-DDD		0.016					0.000106	0.0004	0.0001	0.0001	0.01	0.000169	1	0.015247
4,4'-DDE		0.019					0.000106	0.0004	0.0001	0.0001	0.01	0.000201	1	0.018106
Aldrin		0.61					0.000106	0.0004	0.0001	0.0001	0.01	0.006459	1	0.581294
Alpha-BHC		0.0036					0.000106	0.0004	0.0001	0.0001	0.01	0.000038	1	0.003431
Alpha-chlordane		0.051					0.000106	0.0004	0.0001	0.0001	0.01	0.00054	1	0.0486
Beta-BHC	0.000009	0.0038					0.000106	0.0004	0.0001	0.0001	0.01	0.00004	1	0.003621
Delta-BHC		0.002					0.000106	0.0004	0.0001	0.0001	0.01	0.000021	1	0.001906
Dieldrin		0.00028					0.000106	0.0004	0.0001	0.0001	0.01	0.000003	1	0.000267
Endosulfan I		0.23					0.000106	0.0004	0.0001	0.0001	0.01	0.002435	1	0.219176
Endosulfan II		0.02					0.000106	0.0004	0.0001	0.0001	0.01	0.000212	1	0.019059
Endosulfan sulfate		0.0054					0.000106	0.0004	0.0001	0.0001	0.01	0.000057	1	0.005146
Endrin	0.000004	0.0022					0.000106	0.0004	0.0001	0.0001	0.01	0.000023	1	0.002096
Endrin aldehyde		0.015					0.000106	0.0004	0.0001	0.0001	0.01	0.000159	1	0.014294
Endrin ketone		0.0071					0.000106	0.0004	0.0001	0.0001	0.01	0.000075	1	0.006766

Table B-1
Calculations of Contaminant Intake for the Crawfish
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Intake Factor (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (90 days) (mg/kg)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)						
			Mollusk	Benthic Fish	Pelagic Fish			Mollusk	Benthic Fish	Pelagic Fish				
Gamma-BHC (lindane)		0.0065					0.000106	0.0004	0.0001	0.0001	0.01	0.000069	1	0.006194
Gamma-chlordane		0.011					0.000106	0.0004	0.0001	0.0001	0.01	0.000116	1	0.010482
Heptachlor epoxide		0.17					0.000106	0.0004	0.0001	0.0001	0.01	0.0018	1	0.162
Methoxychlor		0.067					0.000106	0.0004	0.0001	0.0001	0.01	0.000709	1	0.063847
Metals														
Aluminum	3.48	36100					0.000106	0.0004	0.0001	0.0001	0.01	382.2353	0.01	344.0118
Arsenic		618	0.69				0.000106	0.0004	0.0001	0.0001	0.01	6.571129	0.01	5.914016
Barium	0.121	1210					0.000106	0.0004	0.0001	0.0001	0.01	12.81176	0.01	11.53059
Beryllium		2.4					0.000106	0.0004	0.0001	0.0001	0.01	0.025412	0.01	0.022871
Cadmium	0.0086	62.3	8.6				0.000106	0.0004	0.0001	0.0001	0.01	1.003647	0.01	0.903282
Chromium	0.0045	94.8	1.3	1.2	2		0.000106	0.0004	0.0001	0.0001	0.01	1.087765	0.01	0.978988
Cobalt		113			0		0.000106	0.0004	0.0001	0.0001	0.01	1.196471	0.01	1.076824
Copper	0.0095	929	9.2	11.6	49.5		0.000106	0.0004	0.0001	0.0001	0.01	10.81547	0.01	9.733924
Iron	3.28	49000					0.000106	0.0004	0.0001	0.0001	0.01	518.8235	0.01	466.9412
Lead	0.0829	1410	1.7		3.9		0.000106	0.0004	0.0001	0.0001	0.01	15.03641	0.01	13.53277
Magnesium	7.86	8690					0.000106	0.0004	0.0001	0.0001	0.01	92.01176	0.01	82.81059
Manganese	1.69	1870					0.000106	0.0004	0.0001	0.0001	0.01	19.8	0.01	17.82
Mercury	0.107	0.65	0.04	0.27	0.6		0.000106	0.0004	0.0001	0.0001	0.01	0.017182	0.01	0.015464
Nickel		140					0.000106	0.0004	0.0001	0.0001	0.01	1.482353	0.01	1.334118

Table B-1
Calculations of Contaminant Intake for the Crawfish
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Intake Factor (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (90 days) (mg/kg)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)						
			Mollusk	Benthic Fish	Pelagic Fish			Mollusk	Benthic Fish	Pelagic Fish				
Potassium	10.3	3870					0.000106	0.0004	0.0001	0.0001	0.01	40.97647	0.01	36.87882
Selenium	0.0022	0.92	0.55	0.45	0.85		0.000106	0.0004	0.0001	0.0001	0.01	0.044741	0.01	0.040267
Silver		11.8					0.000106	0.0004	0.0001	0.0001	0.01	0.124941	0.01	0.112447
Vanadium	0.0273	82					0.000106	0.0004	0.0001	0.0001	0.01	0.868235	0.01	0.781412
Zinc		1820	45.2	2.62	33.7		0.000106	0.0004	0.0001	0.0001	0.01	21.44179	0.01	19.29761

Table B-2
Calculations of Contaminant Intake for the Pallid Sturgeon

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (365 days) (mg/kg)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)						
			Mollusk	Benthic Fish	Crayfish			Mollusk	Benthic Fish	Crayfish				
Volatile Organic Analytes														
1,1,1 - Trichloroethane		0.003			0.000029		0.046667	0.02	0.02	0.1	2	0.00007	0.01	0.000261
1,1,2,2, Tetrachloroethane	0.017	33			0.314471		0.046667	0.02	0.02	0.1	2	0.785724	0.01	2.867891
1,1,2- Trichloroethane	0.15	4.1			0.039071		0.046667	0.02	0.02	0.1	2	0.09762	0.01	0.356314
1,1 - Dichloroethane	0.006	0.009			0.000086		0.046667	0.02	0.02	0.1	2	0.000214	0.01	0.000782
1,2- Dichloroethane	0.38	0.99			0.009434		0.046667	0.02	0.02	0.1	2	0.023572	0.01	0.086037
1,2- Dichloroethene (Total)	0.078	1.1			0.010482		0.046667	0.02	0.02	0.1	2	0.026191	0.01	0.095596
1,2- Dichloropropane	0.14	2.5			0.023824		0.046667	0.02	0.02	0.1	2	0.059525	0.01	0.217264
2-Butanone	0.03	0.12			0.001144		0.046667	0.02	0.02	0.1	2	0.002857	0.01	0.010429
Acetone	0.066	14			0.133412		0.046667	0.02	0.02	0.1	2	0.333337	0.01	1.216681
Benzene		0.2			0.001906		0.046667	0.02	0.02	0.1	2	0.004762	0.01	0.017381
Carbon disulfide		1.5			0.014294		0.046667	0.02	0.02	0.1	2	0.035715	0.01	0.130359
Chloroform		0.002			0.000019		0.046667	0.02	0.02	0.1	2	0.00005	0.01	0.000174
Ethylbenzene		1.8			0.017153		0.046667	0.02	0.02	0.1	2	0.042858	0.01	0.15643
Methylene chloride	0.009	0.39			0.003716		0.046667	0.02	0.02	0.1	2	0.009286	0.01	0.033893
Tetrachloroethene	0.008	220			2.096471		0.046667	0.02	0.02	0.1	2	5.238157	0.01	19.11927
Toluene	0.01	4.4			0.041929		0.046667	0.02	0.02	0.1	2	0.104763	0.01	0.382385
Trichloroethene	0.032	40			0.381176		0.046667	0.02	0.02	0.1	2	0.952392	0.01	3.476231
Vinyl chloride	0.06	0.28			0.002668		0.046667	0.02	0.02	0.1	2	0.006667	0.01	0.024334
Xylenes (Total)	0.003	0.31			0.002954		0.046667	0.02	0.02	0.1	2	0.007381	0.01	0.026941
Chlorinated Benzenes														
1,2,4 -Trichlorobenzene		84			8.004706		0.046667	0.02	0.02	0.1	2	2.360235	0.1	86.14859

Table B-2
Calculations of Contaminant Intake for the Pallid Sturgeon
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (365 days) (mg/kg)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)						
			Mollusk	Benthic Fish	Crayfish			Mollusk	Benthic Fish	Crayfish				
1,2- Dichlorobenzene		3.6			0.343059		0.046667	0.02	0.02	0.1	2	0.101153	0.1	3.692082
1,3 - Dichlorobenzene		8.3			0.790941		0.046667	0.02	0.02	0.1	2	0.233214	0.1	8.512301
1,4 - Dichlorobenzene		8.3			0.790941		0.046667	0.02	0.02	0.1	2	0.233214	0.1	8.512301
Chlorobenzene		2.3			0.219176		0.046667	0.02	0.02	0.1	2	0.064625	0.1	2.35883
Hexachlorobenzene		470	373	822	45.0451		0.046667	0.02	0.02	0.1	2	25.16892	0.1	918.6656
PAHs														
2-Methylnaphthalene	0.003	13			1.238824		0.046667	0.02	0.02	0.1	2	0.365275	0.1	13.33252
Acenaphthene		2.5			0.238235		0.046667	0.02	0.02	0.1	2	0.070245	0.1	2.563946
Acenaphthylene		1.1			0.104824		0.046667	0.02	0.02	0.1	2	0.030908	0.1	1.128136
Anthracene		2.3			0.219176		0.046667	0.02	0.02	0.1	2	0.064625	0.1	2.35883
Benzo(a)anthracene		3			0.285882		0.046667	0.02	0.02	0.1	2	0.084294	0.1	3.076735
Benzo(a)pyrene		0.56			0.053365		0.046667	0.02	0.02	0.1	2	0.015735	0.1	0.574324
Benzo(b)fluoranthene		0.74			0.070518		0.046667	0.02	0.02	0.1	2	0.020793	0.1	0.758928
Benzo(g,h,i) perylene		0.073			0.006956		0.046667	0.02	0.02	0.1	2	0.002051	0.1	0.074867
Benzo(k)fluoranthene		0.74			0.070518		0.046667	0.02	0.02	0.1	2	0.020793	0.1	0.758928
Chrysene		4			0.381176		0.046667	0.02	0.02	0.1	2	0.112392	0.1	4.102314
Fluoranthene		3			0.285882		0.046667	0.02	0.02	0.1	2	0.084294	0.1	3.076735
Fluorene		13			1.238824		0.046667	0.02	0.02	0.1	2	0.365275	0.1	13.33252
Naphthalene	0.003	50			4.764706		0.046667	0.02	0.02	0.1	2	1.404902	0.1	51.27892
Phenanthrene		340			32.4		0.046667	0.02	0.02	0.1	2	9.553333	0.1	348.6967
Pyrene		10			0.952941		0.046667	0.02	0.02	0.1	2	0.28098	0.1	10.25578

Table B-2
Calculations of Contaminant Intake for the Pallid Sturgeon
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (365 days) (mg/kg)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)						
			Mollusk	Benthic Fish	Crayfish			Mollusk	Benthic Fish	Crayfish				
Phenolics														
4 - Chloro-3-methylphenol		0.1			0.009529		0.046667	0.02	0.02	0.1	2	0.00281	0.1	0.102558
Phenol		0.097			0.009244		0.046667	0.02	0.02	0.1	2	0.002726	0.1	0.099481
Phthalate Esters														
Bis(2-ethylhexyl)phthalate	0.001	5.9			0.562235		0.046667	0.02	0.02	0.1	2	0.165778	0.1	6.050913
Butylbenzylphthalate		1			0.095294		0.046667	0.02	0.02	0.1	2	0.028098	0.1	1.025578
Di-n-butylphthalate	0.001	1.9			0.181059		0.046667	0.02	0.02	0.1	2	0.053386	0.1	1.948599
Di-n-octylphthalate		12			1.143529		0.046667	0.02	0.02	0.1	2	0.337176	0.1	12.30694
Diethylphthalate		0.46			0.043835		0.046667	0.02	0.02	0.1	2	0.012925	0.1	0.471766
Other SVOCs														
3,3'-Dichlorobenzidine		0.24			0.022871		0.046667	0.02	0.02	0.1	2	0.006744	0.1	0.246139
Carbazole		0.076			0.007242		0.046667	0.02	0.02	0.1	2	0.002135	0.1	0.077944
Hexachlorobutadiene	0.074	12000	597	3600	1144.25		0.046667	0.02	0.02	0.1	2	379.1825	0.1	13840.16
Hexachloroethane		110			10.48235		0.046667	0.02	0.02	0.1	2	3.090784	0.1	112.8136
N-nitrosodiphenylamine	0.004	13			1.238824		0.046667	0.02	0.02	0.1	2	0.365275	0.1	13.33252
PCBs														
Aroclor-1248		5.2			4.955294		0.046667	0.02	0.02	0.1	2	0.369098	1	134.7208
Aroclor-1254		6.4			6.098824		0.046667	0.02	0.02	0.1	2	0.454275	1	165.8102
Aroclor-1260		3			2.858824		0.046667	0.02	0.02	0.1	2	0.212941	1	77.72353
Pesticides														
4,4'-DDD		0.016			0.015247		0.046667	0.02	0.02	0.1	2	0.001136	1	0.414525

Table B-2
Calculations of Contaminant Intake for the Pallid Sturgeon
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (365 days) (mg/kg)
			Biota (ingestion)					Biota (ingestion)						
	Surface Water	Sediment	Mollusk	Benthic Fish	Crayfish	Surface Water	Sediment	Mollusk	Benthic Fish	Crayfish				
4,4'-DDE		0.019			0.018106		0.046667	0.02	0.02	0.1	2	0.001349	1	0.492249
Aldrin		0.61			0.581294		0.046667	0.02	0.02	0.1	2	0.043298	1	15.80378
Alpha-BHC		0.0036			0.003431		0.046667	0.02	0.02	0.1	2	0.000256	1	0.093268
Alpha-chlordane		0.051			0.0486		0.046667	0.02	0.02	0.1	2	0.00362	1	1.3213
Beta-BHC	0.000009	0.0038			0.003621		0.046667	0.02	0.02	0.1	2	0.00027	1	0.09845
Delta-BHC		0.002			0.001906		0.046667	0.02	0.02	0.1	2	0.000142	1	0.051816
Dieldrin		0.00028			0.000267		0.046667	0.02	0.02	0.1	2	0.00002	1	0.007254
Endosulfan I		0.23			0.219176		0.046667	0.02	0.02	0.1	2	0.016325	1	5.958804
Endosulfan II		0.02			0.019059		0.046667	0.02	0.02	0.1	2	0.00142	1	0.518157
Endosulfan sulfate		0.0054			0.005146		0.046667	0.02	0.02	0.1	2	0.000383	1	0.139902
Endrin	0.000004	0.0022			0.002096		0.046667	0.02	0.02	0.1	2	0.000156	1	0.056997
Endrin aldehyde		0.015			0.014294		0.046667	0.02	0.02	0.1	2	0.001065	1	0.388618
Endrin ketone		0.0071			0.006766		0.046667	0.02	0.02	0.1	2	0.000504	1	0.183946
Gamma-BHC (lindane)		0.0065			0.006194		0.046667	0.02	0.02	0.1	2	0.000461	1	0.168401
Gamma-chlordane		0.011			0.010482		0.046667	0.02	0.02	0.1	2	0.000781	1	0.284986
Heptachlor epoxide	0.000002	0.17			0.162		0.046667	0.02	0.02	0.1	2	0.012067	1	4.404333
Methoxychlor		0.067			0.063847		0.046667	0.02	0.02	0.1	2	0.004756	1	1.735825
Metals														
Aluminum	3.48	36100			344.0118		0.046667	0.02	0.02	0.1	2	859.5339	0.01	3137.299
Arsenic		618	0.69		5.914016		0.046667	0.02	0.02	0.1	2	14.7226	0.01	53.73749
Barium	0.121	1210			11.53059		0.046667	0.02	0.02	0.1	2	28.80986	0.01	105.156

Table B-2
Calculations of Contaminant Intake for the Pallid Sturgeon
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)	Retention Factor	Predicted Tissue Concentration (365 days) (mg/kg)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)						
			Mollusk	Benthic Fish	Crayfish			Mollusk	Benthic Fish	Crayfish				
Beryllium		2.4			0.022871		0.046667	0.02	0.02	0.1	2	0.057144	0.01	0.208574
Cadmium	0.0086	62.3	8.6		0.903282		0.046667	0.02	0.02	0.1	2	1.584831	0.01	5.784632
Chromium	0.0045	94.8	1.3	1.2	0.978988		0.046667	0.02	0.02	0.1	2	2.285949	0.01	8.343715
Cobalt		113			1.076824		0.046667	0.02	0.02	0.1	2	2.690508	0.01	9.820354
Copper	0.0095	929	9.2	11.6	9.733924		0.046667	0.02	0.02	0.1	2	22.37136	0.01	81.65547
Iron	3.28	49000			466.9412		0.046667	0.02	0.02	0.1	2	1166.68	0.01	4258.383
Lead	0.0829	1410	1.7		13.53277		0.046667	0.02	0.02	0.1	2	33.59364	0.01	122.6168
Magnesium	7.86	8690			82.81059		0.046667	0.02	0.02	0.1	2	206.9072	0.01	755.2113
Manganese	1.69	1870			17.82		0.046667	0.02	0.02	0.1	2	44.52433	0.01	162.5138
Mercury	0.107	0.65	0.04	0.27	0.015464		0.046667	0.02	0.02	0.1	2	0.01904	0.01	0.069496
Nickel		140			1.334118		0.046667	0.02	0.02	0.1	2	3.333373	0.01	12.16681
Potassium	10.3	3870			36.87882		0.046667	0.02	0.02	0.1	2	92.14394	0.01	336.3254
Selenium	0.0022	0.92	0.55	0.45	0.040267		0.046667	0.02	0.02	0.1	2	0.03348	0.01	0.122202
Silver		11.8			0.112447		0.046667	0.02	0.02	0.1	2	0.280956	0.01	1.025488
Vanadium	0.0273	82			0.781412		0.046667	0.02	0.02	0.1	2	1.952404	0.01	7.126274
Zinc		1820	45.2	26.2	19.29761		0.046667	0.02	0.02	0.1	2	44.14555	0.01	161.1312

Table B-3
Calculations of Contaminant Intake for the Blue Heron

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Benthic Fish	Pelagic Fish	Pallid Sturgeon			Benthic Fish	Pelagic Fish	Pallid Sturgeon		
Volatile Organic Analytes												
1,1,1 - Trichloroethane		0.003			0.000261	0.09	0.04	0.06	0.18	0.12	2	0.00008
1,1,2,2, Tetrachloroethane	0.017	33			2.867891	0.09	0.04	0.06	0.18	0.12	2	0.832838
1,1,2 - Trichloroethane	0.15	4.1			0.356314	0.09	0.04	0.06	0.18	0.12	2	0.110129
1,1 - Dichloroethane	0.006	0.009			0.000782	0.09	0.04	0.06	0.18	0.12	2	0.000497
1,2 - Dichloroethane	0.38	0.99			0.086037	0.09	0.04	0.06	0.18	0.12	2	0.042062
1,2 - Dichloroethene (Total)	0.078	1.1			0.095596	0.09	0.04	0.06	0.18	0.12	2	0.031246
1,2 - Dichloropropane	0.14	2.5			0.217264	0.09	0.04	0.06	0.18	0.12	2	0.069336
2-Butanone	0.03	0.12			0.010429	0.09	0.04	0.06	0.18	0.12	2	0.004376
Acetone	0.066	14			1.216681	0.09	0.04	0.06	0.18	0.12	2	0.355971
Benzene		0.2			0.017381	0.09	0.04	0.06	0.18	0.12	2	0.005043
Carbon disulfide		1.5			0.130359	0.09	0.04	0.06	0.18	0.12	2	0.037822
Chloroform		0.002			0.000174	0.09	0.04	0.06	0.18	0.12	2	0.00005
Ethylbenzene		1.8			0.15643	0.09	0.04	0.06	0.18	0.12	2	0.045386
Methylene chloride	0.009	0.39			0.033893	0.09	0.04	0.06	0.18	0.12	2	0.010239
Tetrachloroethene	0.008	220			19.11927	0.09	0.04	0.06	0.18	0.12	2	5.547516
Toluene	0.01	4.4			0.382385	0.09	0.04	0.06	0.18	0.12	2	0.111393
Trichloroethene	0.032	40			3.476231	0.09	0.04	0.06	0.18	0.12	2	1.010014
Vinyl chloride	0.06	0.28			0.024334	0.09	0.04	0.06	0.18	0.12	2	0.00976
Xylenes (Total)	0.003	0.31			0.026941	0.09	0.04	0.06	0.18	0.12	2	0.007951
Chlorinated Benzenes												
1,2,4 -trichlorobenzene		84			86.14859	0.09	0.04	0.06	0.18	0.12	2	6.848915

Table B-3
Calculations of Contaminant Intake for the Blue Heron
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Benthic Fish	Pelagic Fish	Pallid Sturgeon			Benthic Fish	Pelagic Fish	Pallid Sturgeon		
1,2 - Dichlorobenzene		3.6			3.692082	0.09	0.04	0.06	0.18	0.12	2	0.293525
1,3 - Dichlorobenzene		8.3			8.512301	0.09	0.04	0.06	0.18	0.12	2	0.676738
1,4 - Dichlorobenzene		8.3			8.512301	0.09	0.04	0.06	0.18	0.12	2	0.676738
Chlorobenzene		2.3			2.35883	0.09	0.04	0.06	0.18	0.12	2	0.18753
Hexachlorobenzene		470	0.822	0.54	918.6656	0.09	0.04	0.06	0.18	0.12	2	64.5932
PAHs												
2 -Methylnaphthalene	0.003	13			13.33252	0.09	0.04	0.06	0.18	0.12	2	1.060086
Acenaphthene		2.5			2.563946	0.09	0.04	0.06	0.18	0.12	2	0.203837
Acenaphthylene		1.1			1.128136	0.09	0.04	0.06	0.18	0.12	2	0.089688
Anthracene		2.3			2.35883	0.09	0.04	0.06	0.18	0.12	2	0.18753
Benzo(a)anthracene		3			3.076735	0.09	0.04	0.06	0.18	0.12	2	0.244604
Benzo(a)pyrene		0.56			0.574324	0.09	0.04	0.06	0.18	0.12	2	0.045659
Benzo(b)fluoranthene		0.74			0.758928	0.09	0.04	0.06	0.18	0.12	2	0.060336
Benzo(g,h,i) perylene		0.073			0.074867	0.09	0.04	0.06	0.18	0.12	2	0.005952
Benzo(k)fluoranthene		0.74			0.758928	0.09	0.04	0.06	0.18	0.12	2	0.060336
Chrysene		4			4.102314	0.09	0.04	0.06	0.18	0.12	2	0.326139
Fluoranthene		3			3.076735	0.09	0.04	0.06	0.18	0.12	2	0.244604
Fluorene		13			13.33252	0.09	0.04	0.06	0.18	0.12	2	1.059951
Naphthalene	0.003	50			51.27892	0.09	0.04	0.06	0.18	0.12	2	4.07687
Phenanthrene		340			348.6967	0.09	0.04	0.06	0.18	0.12	2	27.7218

Table B-3
Calculations of Contaminant Intake for the Blue Heron
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Benthic Fish	Pelagic Fish	Pallid Sturgeon			Benthic Fish	Pelagic Fish	Pallid Sturgeon		
Pyrene		10			10.25578	0.09	0.04	0.06	0.18	0.12	2	0.815347
Phenolics												
4 - Chloro-3-methylphenol		0.1			0.102558	0.09	0.04	0.06	0.18	0.12	2	0.008153
Phenol		0.097			0.099481	0.09	0.04	0.06	0.18	0.12	2	0.007909
Phthalate Esters												
Bis(2-ethylhexyl)phthalate	0.001	5.9			6.050913	0.09	0.04	0.06	0.18	0.12	2	0.4811
Butylbenzylphthalate		1			1.025578	0.09	0.04	0.06	0.18	0.12	2	0.081535
Di-n-butylphthalate	0.001	1.9			1.948599	0.09	0.04	0.06	0.18	0.12	2	0.154961
Di-n-octylphthalate		12			12.30694	0.09	0.04	0.06	0.18	0.12	2	0.978416
Diethylphthalate		0.46			0.471766	0.09	0.04	0.06	0.18	0.12	2	0.037506
Other SVOCs												
3,3'-Dichlorobenzidine		0.24			0.246139	0.09	0.04	0.06	0.18	0.12	2	0.019568
Carbazole		0.076			0.077944	0.09	0.04	0.06	0.18	0.12	2	0.006197
Hexachlorobutadiene	0.074	12000	3.6	2.02	13840.16	0.09	0.04	0.06	0.18	0.12	2	1070.703
Hexachloroethane		110			112.8136	0.09	0.04	0.06	0.18	0.12	2	8.968818
N-nitrosodiphenylamine	0.004	13			13.33252	0.09	0.04	0.06	0.18	0.12	2	1.060131
PCBs												
Aroclor-1248		5.2			134.7208	0.09	0.04	0.06	0.18	0.12	2	8.187247
Aroclor-1254		6.4			165.8102	0.09	0.04	0.06	0.18	0.12	2	10.07661
Aroclor-1260		3			77.72353	0.09	0.04	0.06	0.18	0.12	2	4.723412

Table B-3
Calculations of Contaminant Intake for the Blue Heron
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Benthic Fish	Pelagic Fish	Pallid Sturgeon			Benthic Fish	Pelagic Fish	Pallid Sturgeon		
Pesticides												
4,4'-DDD		0.016			0.414525	0.09	0.04	0.06	0.18	0.12	2	0.025192
4,4'-DDE		0.019			0.492249	0.09	0.04	0.06	0.18	0.12	2	0.029915
Aldrin		0.61			15.80378	0.09	0.04	0.06	0.18	0.12	2	0.960427
Alpha-BHC		0.0036			0.093268	0.09	0.04	0.06	0.18	0.12	2	0.005668
Alpha-chlordane		0.051			1.3213	0.09	0.04	0.06	0.18	0.12	2	0.080298
Beta-BHC	0.000009	0.0038			0.09845	0.09	0.04	0.06	0.18	0.12	2	0.005983
Delta-BHC		0.002			0.051816	0.09	0.04	0.06	0.18	0.12	2	0.003149
Dieldrin		0.00028			0.007254	0.09	0.04	0.06	0.18	0.12	2	0.000441
Endosulfan I		0.23			5.958804	0.09	0.04	0.06	0.18	0.12	2	0.362128
Endosulfan II		0.02			0.518157	0.09	0.04	0.06	0.18	0.12	2	0.031489
Endosulfan sulfate		0.0054			0.139902	0.09	0.04	0.06	0.18	0.12	2	0.008502
Endrin	0.000004	0.0022			0.056997	0.09	0.04	0.06	0.18	0.12	2	0.003464
Endrin aldehyde		0.015			0.388618	0.09	0.04	0.06	0.18	0.12	2	0.023617
Endrin ketone		0.0071			0.183946	0.09	0.04	0.06	0.18	0.12	2	0.011179
Gamma-BHC (lindane)		0.0065			0.168401	0.09	0.04	0.06	0.18	0.12	2	0.010234
Gamma-chlordane		0.011			0.284986	0.09	0.04	0.06	0.18	0.12	2	0.017319
Heptachlor epoxide	0.000002	0.17			4.404333	0.09	0.04	0.06	0.18	0.12	2	0.26766
Methoxychlor		0.067			1.735825	0.09	0.04	0.06	0.18	0.12	2	0.10549

Table B-3
Calculations of Contaminant Intake for the Blue Heron
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Benthic Fish	Pelagic Fish	Pallid Sturgeon			Benthic Fish	Pelagic Fish	Pallid Sturgeon		
Metals												
Aluminum	3.48	36100			3137.299	0.09	0.04	0.06	0.18	0.12	2	910.3945
Arsenic		618			53.73749	0.09	0.04	0.06	0.18	0.12	2	15.58425
Barium	0.121	1210			105.156	0.09	0.04	0.06	0.18	0.12	2	30.5148
Beryllium		2.4			0.208574	0.09	0.04	0.06	0.18	0.12	2	0.060514
Cadmium	0.0086	62.3			5.784632	0.09	0.04	0.06	0.18	0.12	2	1.593465
Chromium	0.0045	94.8	1.2	2	8.343715	0.09	0.04	0.06	0.18	0.12	2	2.612825
Cobalt		113			9.820354	0.09	0.04	0.06	0.18	0.12	2	2.849221
Copper	0.0095	929	11.6	49.5	81.65547	0.09	0.04	0.06	0.18	0.12	2	28.28276
Iron	3.28	49000			4258.383	0.09	0.04	0.06	0.18	0.12	2	1235.651
Lead	0.0829	1410		3.9	122.6168	0.09	0.04	0.06	0.18	0.12	2	35.91174
Magnesium	7.86	8690			755.2113	0.09	0.04	0.06	0.18	0.12	2	219.4664
Manganese	1.69	1870			162.5138	0.09	0.04	0.06	0.18	0.12	2	47.22688
Mercury	0.107	0.65	0.27	0.6	0.069496	0.09	0.04	0.06	0.18	0.12	2	0.084085
Nickel		140			12.16681	0.09	0.04	0.06	0.18	0.12	2	3.530009
Potassium	10.3	3870			336.3254	0.09	0.04	0.06	0.18	0.12	2	98.04302
Selenium	0.0022	0.92	0.45	0.85	0.122202	0.09	0.04	0.06	0.18	0.12	2	0.115831
Silver		11.8			1.025488	0.09	0.04	0.06	0.18	0.12	2	0.297529
Vanadium	0.0273	82			7.126274	0.09	0.04	0.06	0.18	0.12	2	2.068805
Zinc		1820	2.62	33.7	161.1312	0.09	0.04	0.06	0.18	0.12	2	49.17947

Table B-4
Calculations of Contaminant Intake for the Bald Eagle

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Pelagic Fish	Pallid Sturgeon			Duck	Pelagic Fish	Pallid Sturgeon		
Volatile Organic Analytes												
1,1,1 - Trichloroethane		0.003			0.000261	0.1295	0.023947	0.105	0.175	0.175	3.5	0.00003
1,1,2,2, Tetrachloroethane	0.017	33			2.867891	0.1295	0.023947	0.105	0.175	0.175	3.5	0.369813
1,1,2 - Trichloroethane	0.15	4.1			0.356314	0.1295	0.023947	0.105	0.175	0.175	3.5	0.051418
1,1 - Dichloroethane	0.006	0.009			0.000782	0.1295	0.023947	0.105	0.175	0.175	3.5	0.000323
1,2 - Dichloroethane	0.38	0.99			0.086037	0.1295	0.023947	0.105	0.175	0.175	3.5	0.025136
1,2 - Dichloroethene (Total)	0.078	1.1			0.095596	0.1295	0.023947	0.105	0.175	0.175	3.5	0.015192
1,2 - Dichloropropane	0.14	2.5			0.217264	0.1295	0.023947	0.105	0.175	0.175	3.5	0.033148
2-Butanone	0.03	0.12			0.010429	0.1295	0.023947	0.105	0.175	0.175	3.5	0.002452
Acetone	0.066	14			1.216681	0.1295	0.023947	0.105	0.175	0.175	3.5	0.159066
Benzene		0.2			0.017381	0.1295	0.023947	0.105	0.175	0.175	3.5	0.002237
Carbon disulfide		1.5			0.130359	0.1295	0.023947	0.105	0.175	0.175	3.5	0.016781
Chloroform		0.002			0.000174	0.1295	0.023947	0.105	0.175	0.175	3.5	0.00002
Ethylbenzene		1.8			0.15643	0.1295	0.023947	0.105	0.175	0.175	3.5	0.020137
Methylene chloride	0.009	0.39			0.033893	0.1295	0.023947	0.105	0.175	0.175	3.5	0.004696
Tetrachloroethene	0.008	220			19.11927	0.1295	0.023947	0.105	0.175	0.175	3.5	2.461523
Toluene	0.01	4.4			0.382385	0.1295	0.023947	0.105	0.175	0.175	3.5	0.049595
Trichloroethene	0.032	40			3.476231	0.1295	0.023947	0.105	0.175	0.175	3.5	0.44868
Vinyl chloride	0.06	0.28			0.024334	0.1295	0.023947	0.105	0.175	0.175	3.5	0.005352
Xylenes (total)	0.003	0.31			0.026941	0.1295	0.023947	0.105	0.175	0.175	3.5	0.003579

Table B-4
Calculations of Contaminant Intake for the Bald Eagle
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Pelagic Fish	Pallid Sturgeon			Duck	Pelagic Fish	Pallid Sturgeon		
Chlorinated Benzenes												
1,2,4 -Trichlorobenzene		84			86.14859	0.1295	0.023947	0.105	0.175	0.175	3.5	4.882166
1,2 - Dichlorobenzene		3.6			3.692082	0.1295	0.023947	0.105	0.175	0.175	3.5	0.209236
1,3 - Dichlorobenzene		8.3			8.512301	0.1295	0.023947	0.105	0.175	0.175	3.5	0.482405
1,4 - Dichlorobenzene		8.3			8.512301	0.1295	0.023947	0.105	0.175	0.175	3.5	0.482405
Chlorobenzene		2.3			2.35883	0.1295	0.023947	0.105	0.175	0.175	3.5	0.133678
Hexachlorobenzene		470	0.0366	0.54	918.6656	0.1295	0.023947	0.105	0.175	0.175	3.5	49.17717
PAHs												
2 -Methylnaphthalene	0.003	13			13.33252	0.1295	0.023947	0.105	0.175	0.175	3.5	0.755684
Acenaphthene		2.5			2.563946	0.1295	0.023947	0.105	0.175	0.175	3.5	0.145303
Acenaphthylene		1.1			1.128136	0.1295	0.023947	0.105	0.175	0.175	3.5	0.063933
Anthracene		2.3			2.35883	0.1295	0.023947	0.105	0.175	0.175	3.5	0.133678
Benzo(a)anthracene		3			3.076735	0.1295	0.023947	0.105	0.175	0.175	3.5	0.174363
Benzo(a)pyrene		0.56			0.574324	0.1295	0.023947	0.105	0.175	0.175	3.5	0.032548
Benzo(b)fluoranthene		0.74			0.758928	0.1295	0.023947	0.105	0.175	0.175	3.5	0.04301
Benzo(g,h,i) perylene		0.073			0.074867	0.1295	0.023947	0.105	0.175	0.175	3.5	0.004243
Benzo(k)fluoranthene		0.74			0.758928	0.1295	0.023947	0.105	0.175	0.175	3.5	0.04301
Chrysene		4			4.102314	0.1295	0.023947	0.105	0.175	0.175	3.5	0.232484
Fluoranthene		3			3.076735	0.1295	0.023947	0.105	0.175	0.175	3.5	0.174363
Fluorene		13			13.33252	0.1295	0.023947	0.105	0.175	0.175	3.5	0.755573

Table B-4
Calculations of Contaminant Intake for the Bald Eagle
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Pelagic Fish	Pallid Sturgeon			Duck	Pelagic Fish	Pallid Sturgeon		
Naphthalene	0.003	50			51.27892	0.1295	0.023947	0.105	0.175	0.175	3.5	2.906162
Phenanthrene		340			348.6967	0.1295	0.023947	0.105	0.175	0.175	3.5	19.76115
Pyrene		10			10.25578	0.1295	0.023947	0.105	0.175	0.175	3.5	0.58121
Phenolics												
4 - Chloro-3-methylphenol		0.1			0.102558	0.1295	0.023947	0.105	0.175	0.175	3.5	0.005812
Phenol		0.097			0.099481	0.1295	0.023947	0.105	0.175	0.175	3.5	0.005638
Phthalate Esters												
Bis(2-ethylhexyl)phthalate	0.001	5.9			6.050913	0.1295	0.023947	0.105	0.175	0.175	3.5	0.342951
Butylbenzylphthalate		1			1.025578	0.1295	0.023947	0.105	0.175	0.175	3.5	0.058121
Di-n-butylphthalate	0.001	1.9			1.948599	0.1295	0.023947	0.105	0.175	0.175	3.5	0.110467
Di-n-octylphthalate		12			12.30694	0.1295	0.023947	0.105	0.175	0.175	3.5	0.697452
Diethylphthalate		0.46			0.471766	0.1295	0.023947	0.105	0.175	0.175	3.5	0.026736
Other SVOCs												
3,3'-Dichlorobenzidine		0.24			0.246139	0.1295	0.023947	0.105	0.175	0.175	3.5	0.013949
Carbazole		0.076			0.077944	0.1295	0.023947	0.105	0.175	0.175	3.5	0.004417
Hexachlorobutadiene	0.074	12000	0.0644	2.02	13840.16	0.1295	0.023947	0.105	0.175	0.175	3.5	774.219
Hexachloroethane		110			112.8136	0.1295	0.023947	0.105	0.175	0.175	3.5	6.393313
N-nitrosodiphenylamine	0.004	13			13.33252	0.1295	0.023947	0.105	0.175	0.175	3.5	0.755721
PCBs												
Aroclor-1248		5.2			134.7208	0.1295	0.023947	0.105	0.175	0.175	3.5	6.771618

Table B-4
Calculations of Contaminant Intake for the Bald Eagle
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Pelagic Fish	Pallid Sturgeon			Duck	Pelagic Fish	Pallid Sturgeon		
Aroclor-1254		6.4			165.8102	0.1295	0.023947	0.105	0.175	0.175	3.5	8.334299
Aroclor-1260		3			77.72353	0.1295	0.023947	0.105	0.175	0.175	3.5	3.906703
Pesticides												
4,4'-DDD		0.016			0.414525	0.1295	0.023947	0.105	0.175	0.175	3.5	0.020836
4,4'-DDE		0.019			0.492249	0.1295	0.023947	0.105	0.175	0.175	3.5	0.024742
Aldrin		0.61			15.80378	0.1295	0.023947	0.105	0.175	0.175	3.5	0.794363
Alpha-BHC		0.0036			0.093268	0.1295	0.023947	0.105	0.175	0.175	3.5	0.004688
Alpha-chlordane		0.051			1.3213	0.1295	0.023947	0.105	0.175	0.175	3.5	0.066414
Beta-BHC	0.000009	0.0038			0.09845	0.1295	0.023947	0.105	0.175	0.175	3.5	0.004949
Delta-BHC		0.002			0.051816	0.1295	0.023947	0.105	0.175	0.175	3.5	0.002604
Dieldrin		0.00028			0.007254	0.1295	0.023947	0.105	0.175	0.175	3.5	0.000365
Endosulfan I		0.23			5.958804	0.1295	0.023947	0.105	0.175	0.175	3.5	0.299514
Endosulfan II		0.02			0.518157	0.1295	0.023947	0.105	0.175	0.175	3.5	0.026045
Endosulfan sulfate		0.0054			0.139902	0.1295	0.023947	0.105	0.175	0.175	3.5	0.007032
Endrin	0.000004	0.0022			0.056997	0.1295	0.023947	0.105	0.175	0.175	3.5	0.002865
Endrin aldehyde		0.015			0.388618	0.1295	0.023947	0.105	0.175	0.175	3.5	0.019534
Endrin ketone		0.0071			0.183946	0.1295	0.023947	0.105	0.175	0.175	3.5	0.009246
Gamma-BHC (lindane)		0.0065			0.168401	0.1295	0.023947	0.105	0.175	0.175	3.5	0.008465
Gamma-chlordane		0.011			0.284986	0.1295	0.023947	0.105	0.175	0.175	3.5	0.014325
Heptachlor epoxide	0.000002	0.17			4.404333	0.1295	0.023947	0.105	0.175	0.175	3.5	0.22138

Table B-4
Calculations of Contaminant Intake for the Bald Eagle
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Pelagic Fish	Pallid Sturgeon			Duck	Pelagic Fish	Pallid Sturgeon		
Methoxychlor		0.067			1.735825	0.1295	0.023947	0.105	0.175	0.175	3.5	0.08725
Metals												
Aluminum	3.48	36100			3137.299	0.1295	0.023947	0.105	0.175	0.175	3.5	403.9937
Arsenic		618			53.73749	0.1295	0.023947	0.105	0.175	0.175	3.5	6.915296
Barium	0.121	1210			105.156	0.1295	0.023947	0.105	0.175	0.175	3.5	13.54122
Beryllium		2.4			0.208574	0.1295	0.023947	0.105	0.175	0.175	3.5	0.02685
Cadmium	0.0086	62.3			5.784632	0.1295	0.023947	0.105	0.175	0.175	3.5	0.715813
Chromium	0.0045	94.8	0.97	2	8.343715	0.1295	0.023947	0.105	0.175	0.175	3.5	1.195084
Cobalt		113			9.820354	0.1295	0.023947	0.105	0.175	0.175	3.5	1.264176
Copper	0.0095	929	5.6	49.5	81.65547	0.1295	0.023947	0.105	0.175	0.175	3.5	13.08244
Iron	3.28	49000			4258.383	0.1295	0.023947	0.105	0.175	0.175	3.5	548.3037
Lead	0.0829	1410		3.9	122.6168	0.1295	0.023947	0.105	0.175	0.175	3.5	15.97627
Magnesium	7.86	8690			755.2113	0.1295	0.023947	0.105	0.175	0.175	3.5	97.50928
Manganese	1.69	1870			162.5138	0.1295	0.023947	0.105	0.175	0.175	3.5	20.98296
Mercury	0.107	0.65		0.6	0.069496	0.1295	0.023947	0.105	0.175	0.175	3.5	0.041881
Nickel		140			12.16681	0.1295	0.023947	0.105	0.175	0.175	3.5	1.566235
Potassium	10.3	3870			336.3254	0.1295	0.023947	0.105	0.175	0.175	3.5	43.67632
Selenium	0.0022	0.92		0.85	0.122202	0.1295	0.023947	0.105	0.175	0.175	3.5	0.054986
Silver		11.8			1.025488	0.1295	0.023947	0.105	0.175	0.175	3.5	0.132011
Vanadium	0.0273	82			7.126274	0.1295	0.023947	0.105	0.175	0.175	3.5	0.918376

Table B-4
Calculations of Contaminant Intake for the Bald Eagle
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Pelagic Fish	Pallid Sturgeon			Duck	Pelagic Fish	Pallid Sturgeon		
Zinc		1820	11.4	33.7	161.1312	0.1295	0.023947	0.105	0.175	0.175	3.5	22.53619

Table B-5
Calculations of Contaminant Intake for the Mink

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Crawfish	Pallid Sturgeon			Duck	Crawfish	Pallid Sturgeon		
Volatile Organic Analytes												
1,1,1 - Trichloroethane		0.003		0.000029	0.000261	0.088	0.009684	0.008	0.088	0.088	0.8	0.00007
1,1,2,2, Tetrachloroethane	0.017	33		0.314471	2.867891	0.088	0.009684	0.008	0.088	0.088	0.8	0.751403
1,1,2 - Trichloroethane	0.15	4.1		0.039071	0.356314	0.088	0.009684	0.008	0.088	0.088	0.8	0.109624
1,1 - Dichloroethane	0.006	0.009		0.000086	0.000782	0.088	0.009684	0.008	0.088	0.088	0.8	0.000864
1,2 - Dichloroethane	0.38	0.99		0.009434	0.086037	0.088	0.009684	0.008	0.088	0.088	0.8	0.064286
1,2 - Dichloroethene (Total)	0.078	1.1		0.010482	0.095596	0.088	0.009684	0.008	0.088	0.088	0.8	0.033564
1,2 - Dichloropropane	0.14	2.5		0.023824	0.217264	0.088	0.009684	0.008	0.088	0.088	0.8	0.072183
2-Butanone	0.03	0.12		0.001144	0.010429	0.088	0.009684	0.008	0.088	0.088	0.8	0.006026
Acetone	0.066	14		0.133412	1.216681	0.088	0.009684	0.008	0.088	0.088	0.8	0.325244
Benzene		0.2		0.001906	0.017381	0.088	0.009684	0.008	0.088	0.088	0.8	0.004543
Carbon disulfide		1.5		0.014294	0.130359	0.088	0.009684	0.008	0.088	0.088	0.8	0.03407
Chloroform		0.002		0.000019	0.000174	0.088	0.009684	0.008	0.088	0.088	0.8	0.00005
Ethylbenzene		1.8		0.017153	0.15643	0.088	0.009684	0.008	0.088	0.088	0.8	0.040884
Methylene chloride	0.009	0.39		0.003716	0.033893	0.088	0.009684	0.008	0.088	0.088	0.8	0.009848
Tetrachloroethene	0.008	220		2.096471	19.11927	0.088	0.009684	0.008	0.088	0.088	0.8	4.99777
Toluene	0.01	4.4		0.041929	0.382385	0.088	0.009684	0.008	0.088	0.088	0.8	0.101038
Trichloroethene	0.032	40		0.381176	3.476231	0.088	0.009684	0.008	0.088	0.088	0.8	0.912045
Vinyl chloride	0.06	0.28		0.002668	0.024334	0.088	0.009684	0.008	0.088	0.088	0.8	0.01296
Xylenes (Total)	0.003	0.31		0.002954	0.026941	0.088	0.009684	0.008	0.088	0.088	0.8	0.007371
Chlorinated Benzenes												
1,2,4 -Trichlorobenzene		84		8.004706	86.14859	0.088	0.009684	0.008	0.088	0.088	0.8	11.3737

Table B-5
Calculations of Contaminant Intake for the Mink
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Crawfish	Pallid Sturgeon			Duck	Crawfish	Pallid Sturgeon		
1,2 - Dichlorobenzene		3.6		0.343059	3.692082	0.088	0.009684	0.008	0.088	0.088	0.8	0.487444
1,3 - Dichlorobenzene		8.3		0.790941	8.512301	0.088	0.009684	0.008	0.088	0.088	0.8	1.12383
1,4 - Dichlorobenzene		8.3		0.790941	8.512301	0.088	0.009684	0.008	0.088	0.088	0.8	1.12383
Chlorobenzene		2.3		0.219176	2.35883	0.088	0.009684	0.008	0.088	0.088	0.8	0.311423
Hexachlorobenzene		470	0.0366	45.0451	918.6656	0.088	0.009684	0.008	0.088	0.088	0.8	111.698
PAHs												
2 -Methylnaphthalene	0.003	13		1.238824	13.33252	0.088	0.009684	0.008	0.088	0.088	0.8	1.760546
Acenaphthene		2.5		0.238235	2.563946	0.088	0.009684	0.008	0.088	0.088	0.8	0.338503
Acenaphthylene		1.1		0.104824	1.128136	0.088	0.009684	0.008	0.088	0.088	0.8	0.148941
Anthracene		2.3		0.219176	2.35883	0.088	0.009684	0.008	0.088	0.088	0.8	0.311423
Benzo(a)anthracene		3		0.285882	3.076735	0.088	0.009684	0.008	0.088	0.088	0.8	0.406204
Benzo(a)pyrene		0.56		0.053365	0.574324	0.088	0.009684	0.008	0.088	0.088	0.8	0.075825
Benzo(b)fluoranthene		0.74		0.070518	0.758928	0.088	0.009684	0.008	0.088	0.088	0.8	0.100197
Benzo(g,h,i) perylene		0.073		0.006956	0.074867	0.088	0.009684	0.008	0.088	0.088	0.8	0.009884
Benzo(k)fluoranthene		0.74		0.070518	0.758928	0.088	0.009684	0.008	0.088	0.088	0.8	0.100197
Chrysene		4		0.381176	4.102314	0.088	0.009684	0.008	0.088	0.088	0.8	0.541605
Fluoranthene		3		0.285882	3.076735	0.088	0.009684	0.008	0.088	0.088	0.8	0.406204
Fluorene		13		1.238824	13.33252	0.088	0.009684	0.008	0.088	0.088	0.8	1.760216
Naphthalene	0.003	50		4.764706	51.27892	0.088	0.009684	0.008	0.088	0.088	0.8	6.770392
Phenanthrene		340		32.4	348.6967	0.088	0.009684	0.008	0.088	0.088	0.8	46.03642

Table B-5
Calculations of Contaminant Intake for the Mink
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Crawfish	Pallid Sturgeon			Duck	Crawfish	Pallid Sturgeon		
Pyrene		10		0.952941	10.25578	0.088	0.009684	0.008	0.088	0.088	0.8	1.354012
Phenolics												
4 - Chloro-3-methylphenol		0.1		0.009529	0.102558	0.088	0.009684	0.008	0.088	0.088	0.8	0.01354
Phenol		0.097		0.009244	0.099481	0.088	0.009684	0.008	0.088	0.088	0.8	0.013134
Phthalate Esters												
Bis(2-ethylhexyl)phthalate	0.001	5.9		0.562235	6.050913	0.088	0.009684	0.008	0.088	0.088	0.8	0.798977
Butylbenzylphthalate		1		0.095294	1.025578	0.088	0.009684	0.008	0.088	0.088	0.8	0.135401
Di-n-butylphthalate	0.001	1.9		0.181059	1.948599	0.088	0.009684	0.008	0.088	0.088	0.8	0.257372
Di-n-octylphthalate		12		1.143529	12.30694	0.088	0.009684	0.008	0.088	0.088	0.8	1.624815
Diethylphthalate		0.46		0.043835	0.471766	0.088	0.009684	0.008	0.088	0.088	0.8	0.062285
Other SVOCs												
3,3'-Dichlorobenzidine		0.24		0.022871	0.246139	0.088	0.009684	0.008	0.088	0.088	0.8	0.032496
Carbazole		0.076		0.007242	0.077944	0.088	0.009684	0.008	0.088	0.088	0.8	0.01029
Hexachlorobutadiene	0.074	12000	0.0644	1144.25	13840.16	0.088	0.009684	0.008	0.088	0.088	0.8	1793.557
Hexachloroethane		110		10.48235	112.8136	0.088	0.009684	0.008	0.088	0.088	0.8	14.89414
N-nitrosodiphenylamine	0.004	13		1.238824	13.33252	0.088	0.009684	0.008	0.088	0.088	0.8	1.760656
PCBs												
Aroclor-1248		5.2		4.955294	134.7208	0.088	0.009684	0.008	0.088	0.088	0.8	15.42732
Aroclor-1254		6.4		6.098824	165.8102	0.088	0.009684	0.008	0.088	0.088	0.8	18.98747
Aroclor-1260		3		2.858824	77.72353	0.088	0.009684	0.008	0.088	0.088	0.8	8.900375

Table B-5
Calculations of Contaminant Intake for the Mink
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Crawfish	Pallid Sturgeon			Duck	Crawfish	Pallid Sturgeon		
Pesticides												
4,4'-DDD		0.016		0.015247	0.414525	0.088	0.009684	0.008	0.088	0.088	0.8	0.047469
4,4'-DDE		0.019		0.018106	0.492249	0.088	0.009684	0.008	0.088	0.088	0.8	0.056369
Aldrin		0.61		0.581294	15.80378	0.088	0.009684	0.008	0.088	0.088	0.8	1.809743
Alpha-BHC		0.0036		0.003431	0.093268	0.088	0.009684	0.008	0.088	0.088	0.8	0.01068
Alpha-chlordane		0.051		0.0486	1.3213	0.088	0.009684	0.008	0.088	0.088	0.8	0.151306
Beta-BHC	0.000009	0.0038		0.003621	0.09845	0.088	0.009684	0.008	0.088	0.088	0.8	0.011275
Delta-BHC		0.002		0.001906	0.051816	0.088	0.009684	0.008	0.088	0.088	0.8	0.005934
Dieldrin		0.00028		0.000267	0.007254	0.088	0.009684	0.008	0.088	0.088	0.8	0.000831
Endosulfan I		0.23		0.219176	5.958804	0.088	0.009684	0.008	0.088	0.088	0.8	0.682362
Endosulfan II		0.02		0.019059	0.518157	0.088	0.009684	0.008	0.088	0.088	0.8	0.059336
Endosulfan sulfate		0.0054		0.005146	0.139902	0.088	0.009684	0.008	0.088	0.088	0.8	0.016021
Endrin	0.000004	0.0022		0.002096	0.056997	0.088	0.009684	0.008	0.088	0.088	0.8	0.006527
Endrin aldehyde		0.015		0.014294	0.388618	0.088	0.009684	0.008	0.088	0.088	0.8	0.044502
Endrin ketone		0.0071		0.006766	0.183946	0.088	0.009684	0.008	0.088	0.088	0.8	0.021064
Gamma-BHC (lindane)		0.0065		0.006194	0.168401	0.088	0.009684	0.008	0.088	0.088	0.8	0.019284
Gamma-chlordane		0.011		0.010482	0.284986	0.088	0.009684	0.008	0.088	0.088	0.8	0.032635
Heptachlor epoxide	0.000002	0.17		0.162	4.404333	0.088	0.009684	0.008	0.088	0.088	0.8	0.504355
Methoxychlor		0.067		0.063847	1.735825	0.088	0.009684	0.008	0.088	0.088	0.8	0.198775

Table B-5
Calculations of Contaminant Intake for the Mink
(Continued)

Chemical	Exposure Media Concentrations (mg/kg)					Exposure Media Intake Factors (kg/d)					Body Weight (kg)	Daily Intake (mg/kgBW/d)
	Surface Water	Sediment	Biota (ingestion)			Surface Water	Sediment	Biota (ingestion)				
			Duck	Crawfish	Pallid Sturgeon			Duck	Crawfish	Pallid Sturgeon		
Metals												
Aluminum	3.48	36100		344.0118	3137.299	0.088	0.009684	0.008	0.088	0.088	0.8	820.327
Arsenic		618		5.914016	53.73749	0.088	0.009684	0.008	0.088	0.088	0.8	14.04272
Barium	0.121	1210		11.53059	105.156	0.088	0.009684	0.008	0.088	0.088	0.8	27.4962
Beryllium		2.4		0.022871	0.208574	0.088	0.009684	0.008	0.088	0.088	0.8	0.054512
Cadmium	0.0086	62.3		0.903282	5.784632	0.088	0.009684	0.008	0.088	0.088	0.8	1.490775
Chromium	0.0045	94.8	0.97	0.978988	8.343715	0.088	0.009684	0.008	0.088	0.088	0.8	2.183271
Cobalt		113		1.076824	9.820354	0.088	0.009684	0.008	0.088	0.088	0.8	2.566584
Copper	0.0095	929	5.6	9.733924	81.65547	0.088	0.009684	0.008	0.088	0.088	0.8	21.35567
Iron	3.28	49000		466.9412	4258.383	0.088	0.009684	0.008	0.088	0.088	0.8	1113.304
Lead	0.0829	1410		13.53277	122.6168	0.088	0.009684	0.008	0.088	0.088	0.8	32.05399
Magnesium	7.86	8690		82.81059	755.2113	0.088	0.009684	0.008	0.088	0.088	0.8	198.2417
Manganese	1.69	1870		17.82	162.5138	0.088	0.009684	0.008	0.088	0.088	0.8	42.65946
Mercury	0.107	0.65		0.015464	0.069496	0.088	0.009684	0.008	0.088	0.088	0.8	0.028984
Nickel		140		1.334118	12.16681	0.088	0.009684	0.008	0.088	0.088	0.8	3.179839
Potassium	10.3	3870		36.87882	336.3254	0.088	0.009684	0.008	0.088	0.088	0.8	89.03283
Selenium	0.0022	0.92		0.040267	0.122202	0.088	0.009684	0.008	0.088	0.088	0.8	0.02925
Silver		11.8		0.112447	1.025488	0.088	0.009684	0.008	0.088	0.088	0.8	0.268015
Vanadium	0.0273	82		0.781412	7.126274	0.088	0.009684	0.008	0.088	0.088	0.8	1.86548
Zinc		1820	11.4	19.29761	161.1312	0.088	0.009684	0.008	0.088	0.088	0.8	41.99275

APPENDIX C

CALCULATION OF HAZARD QUOTIENTS

Table C-1
Calculated Hazard Quotients for Surface Water

Chemical	Exposure Media Concentration (mg/kg)	TRV (mg/kg)	HQ
Volatile Organic Analytes			
1,1,2,2, Tetrachloroethane	0.017	2.4	0.0
1,1,2 - Trichloroethane	0.15	9.4	0.0
1,1 - Dichloroethane	0.006		
1,2 - Dichloroethane	0.38	20	0.0
1,2 - Dichloroethene (Total)	0.078	140	0.0
1,2 - Dichloropropane	0.14	138	0.0
2-Butanone	0.03	320	0.0
Acetone	0.066	100	0.0
Methylene Chloride	0.009	193	0.0
Tetrachloroethene	0.008	0.84	0.0
Toluene	0.01	9.4	0.0
Trichloroethene	0.032	21.9	0.0
Vinyl Chloride	0.06		
Xylenes (Total)	0.003	13.5	0.0
PAHs			
2-Methylnaphthalene	0.003	0.6	0.0
Naphthalene	0.003	0.62	0.0
Phthalate Esters			
Bis(2-ethylhexyl)phthalate	0.001	0.36	0.0
Di-n-butylphthalate	0.001	0.003	0.3
Other SVOCs			
Hexachlorobutadiene	0.074	0.0093	8.0
N-nitrosodiphenylamine	0.004	0.009	0.4

Table C-1 (Continued)
Calculated Hazard Quotients for Surface Water

Chemical	Exposure Media Concentration (mg/kg)	TRV (mg/kg)	HQ
Pesticides			
Beta-BHC	0.000009		
Endrin	0.000004	0.0000023	1.7
Heptachlor epoxide	0.000002	0.0000038	0.5
Metals			
Aluminum	3.48		
Barium	0.121	410	0.0
Cadmium	0.0086	0.00066	13.0
Chromium	0.0045	0.12	0.0
Copper	0.0095	0.0065	1.5
Iron	3.28	1	3.3
Lead	0.0829	0.0013	63.8
Magnesium	7.86		
Manganese	1.69		
Mercury	0.107	0.000012	8916.7
Potassium	10.3		
Selenium	0.0022	0.005	0.4
Vanadium	0.0273		
Hazard Index			9009.8

Table C-2
Calculated Hazard Quotients for Sediments

Chemical	Exposure Media Concentration (mg/kg)	TRV (mg/kg)	HQ
Volatile Organic Analytes			
1,1,1 - Trichloroethane	0.003		
1,1,2,2, Tetrachloroethane	33		
1,1,2 - Trichloroethane	4.1		
1,1 - Dichloroethane	0.009		
1,2 - Dichloroethane	0.99		
1,2 - Dichloroethene (Total)	1.1		
1,2 - Dichloropropane	2.5		
2-Butanone	0.12		
Acetone	14		
Benzene	0.2		
Carbon disulfide	1.5		
Chloroform	0.002		
Ethylbenzene	1.8		
Methylene chloride	0.39		
Tetrachloroethene	220		
Toluene	4.4		
Trichloroethene	40		
Vinyl chloride	0.28		
Xylenes (Total)	0.31		
Chlorinated Benzenes			
1,2,4-Trichlorobenzene	84	0.02	4200.0
1,2 - Dichlorobenzene	3.6		
1,3 - Dichlorobenzene	8.3		
1,4 - Dichlorobenzene	8.3		
Chlorobenzene	2.3		

Table C-2
Calculated Hazard Quotients for Sediments
(Continued)

Chemical	Exposure Media Concentration (mg/kg)	TRV (mg/kg)	HQ
Hexachlorobenzene	470		
PAHs			
2 -Methylnaphthalene	13		
Acenaphthene	2.5	0.26	9.6
Acenaphthylene	1.1	0.17	6.5
Anthracene	2.3	3.4	0.7
Benzo(a)anthracene	3	1.3	2.3
Benzo(a)pyrene	0.56	1.8	0.3
Benzo(b)fluoranthene	0.74		
Benzo(g,h,i) perylene	0.073	1.8	0.0
Benzo(k)fluoranthene	0.74	0.24	3.1
Chrysene	4	3.4	1.2
Fluoranthene	3	1.2	2.5
Fluorene	13	8.4	1.5
Naphthalene	50	4.6	10.9
Phenanthrene	340	18.2	18.7
Pyrene	10	6.2	1.6
Phenolics			
4 - chloro-3-methylphenol	0.1		
Phenol	0.097		
Phthalate Esters			
Bis(2-ethylhexyl)phthalate	5.9	1.5	3.9
Butylbenzylphthalate	1		
Di-n-butylphthalate	1.9	0.04	47.5
Di-n-octylphthalate	12		

Table C-2
Calculated Hazard Quotients for Sediments
(Continued)

Chemical	Exposure Media Concentration (mg/kg)	TRV (mg/kg)	HQ
Diethylphthalate	0.46		
Other SVOCs			
3,3'-Dichlorobenzidine	0.24		
Carbazole	0.076		
Hexachlorobutadiene	12000		
Hexachloroethane	110		
N-nitrosodiphenylamine	13		
PCBs			
Aroclor-1248	5.2	0.03	173.3
Aroclor-1254	6.4	0.036	177.8
Aroclor-1260	3	0.005	600.0
Pesticides			
4,4'-DDD	0.016	0.002	8.0
4,4'-DDE	0.019	0.0022	8.6
Aldrin	0.61	0.002	305.0
Alpha-BHC	0.0036	0.006	0.6
Alpha-chlordane	0.051	0.0005	102.0
Beta-BHC	0.0038	0.005	0.8
Delta-BHC	0.002		
Dieldrin	0.00028	0.022	0.0
Endosulfan I	0.23		
Endosulfan II	0.02		
Endosulfan sulfate	0.0054		
Endrin	0.0022	0.0084	0.3
Endrin aldehyde	0.015		

Table C-2
Calculated Hazard Quotients for Sediments
(Continued)

Chemical	Exposure Media Concentration (mg/kg)	TRV (mg/kg)	HQ
Endrin ketone	0.0071		
Gamma-BHC (lindane)	0.0065	0.003	2.2
Gamma-chlordane	0.011	0.0005	22.0
Heptachlor epoxide	0.17	0.005	34.0
Methoxychlor	0.067		
Metals			
Aluminum	36100	27000	1.3
Arsenic	618	150	4.1
Barium	1210		
Beryllium	2.4		
Cadmium	62.3	12	5.2
Chromium	94.8	280	0.3
Cobalt	113	50	2.3
Copper	929	840	1.1
Iron	49000	20000	2.5
Lead	1410	720	2.0
Magnesium	8690	6100	1.4
Manganese	1870	1800	1.0
Mercury	0.65	2.7	0.2
Nickel	140	31	4.5
Potassium	3870		
Selenium	0.92	0.1	9.2
Silver	11.8	4.5	2.6
Vanadium	82		

Table C-2
Calculated Hazard Quotients for Sediments
(Continued)

Chemical	Exposure Media Concentration (mg/kg)	TRV (mg/kg)	HQ
Zinc	1820	1100	1.7
Hazard Index			5784.3

Table C-3
Calculated Hazard Quotients for the Blue Heron

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
Volatile Organic Analytes			
1,1,1 - Trichloroethane	0.00008		
1,1,2,2, Tetrachloroethane	0.8		
1,1,2 - Trichloroethane	0.1		
1,1 - Dichloroethane	0.0005		
1,2 - Dichloroethane	0.04		
1,2 - Dichloroethene (Total)	0.03		
1,2 - Dichloropropane	0.07		
2-Butanone	0.004		
Acetone	0.4		
Benzene	0.005		
Carbon disulfide	0.04		
Chloroform	0.00005		
Ethylbenzene	0.05		
Methylene chloride	0.01		
Tetrachloroethene	5.5		
Toluene	0.1		
Tichloroethene	1		
Vinyl chloride	0.01		
Xylenes (Total)	0.008		
Chlorinated Benzenes			
1,2,4 -Trichlorobenzene	6.8		
1,2 - Dichlorobenzene	0.3		
1,3 - Dichlorobenzene	0.7		
1,4 - Dichlorobenzene	0.7	500	0.0
Chlorobenzene	0.2		
Hexachlorobenzene	64.6	0.2	323.0

Table C-3
Calculated Hazard Quotients for the Blue Heron
(Continued)

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
PAHs			
2 -methylnaphthalene	1.1		
Acenaphthene	0.2	20	0.0
Acenaphthylene	0.09		
Anthracene	0.2	20	0.0
Benzo(a)anthracene	0.2	20	0.0
Benzo(a)pyrene	0.05	20	0.0
Benzo(b)fluoranthene	0.06	20	0.0
Benzo(g,h,i) perylene	0.006	20	0.0
Benzo(k)fluoranthene	0.06	20	0.0
Chrysene	0.3	20	0.0
Fluoranthene	0.2	20	0.0
Fluorene	1.1		
Naphthalene	4.1	20	0.2
Phenanthrene	27.7	20	1.4
Pyrene	0.8	20	0.0
Phenolics			
4 - chloro-3-methylphenol	0.008		
Phenol	0.008		
Phthalate Esters			
Bis(2-ethylhexyl)phthalate	0.5		
Butylbenzylphthalate	0.08		
Di-n-butylphthalate	0.2		
Di-n-octylphthalate	0.98		
Diethylphthalate	0.04		

Table C-3
Calculated Hazard Quotients for the Blue Heron
(Continued)

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
Other SVOCs			
3,3'-Dichlorobenzidine	0.02		
Carbazole	0.006		
Hexachlorobutadiene	1070.7	5	214.1
Hexachloroethane	9		
N-nitrosodiphenylamine	1.1		
PCBs			
Aroclor-1248	8.2	0.22	37.2
Aroclor-1254	10.1	0.035	287.9
Aroclor-1260	4.7	0.035	135.0
Pesticides			
4,4'-DDD	0.03	0.5	0.1
4,4'-DDE	0.03	0.5	0.1
Aldrin	1	2.5	0.4
Alpha-BHC	0.006		
Alpha-chlordane	0.08		
Beta-BHC	0.006		
Delta-BHC	0.003		
Dieldrin	0.0004	0.035	0.0
Endosulfan I	0.4		
Endosulfan II	0.03		
Endosulfan sulfate	0.009		
Endrin	0.003	0.075	0.0
Endrin aldehyde	0.02		
Endrin ketone	0.01		
Gamma-BHC (lindane)	0.01		

Table C-3
Calculated Hazard Quotients for the Blue Heron
(Continued)

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
Gamma-chlordane	0.02		
Heptachlor epoxide	0.3	0.05	5.4
Methoxychlor	0.1		
Metals			
Aluminum	910		
Arsenic	16	5	3.1
Barium	31	0.66	46.2
Beryllium	0.06		
Cadmium	2	0.02	79.7
Chromium	3	0.05	52.3
Cobalt	3		
Copper	28	24.7	1.1
Iron	1236		
Lead	36	1.25	28.7
Magnesium	219		
Manganese	47	24	2.0
Mercury	0.08	0.0005	168.2
Nickel	4	6	0.6
Potassium	98		
Selenium	0.1	0.5	0.2
Silver	0.3	1.75	0.2
Vanadium	2	1.9	1.1
Zinc	49	14	3.5
Hazard Index			1391.7

Table C-4
Calculated Hazard Quotients for the Bald Eagle

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
Volatile Organic Analytes			
1,1,1 - Trichloroethane	0.00003		
1,1,2,2, Tetrachloroethane	0.4		
1,1,2 - Trichloroethane	0.05		
1,1 - Dichloroethane	0.0003		
1,2 - Dichloroethane	0.03		
1,2 - Dichloroethene (Total)	0.015		
1,2 - Dichloropropane	0.03		
2-Butanone	0.002		
Acetone	0.16		
Benzene	0.002		
Carbon disulfide	0.017		
Chloroform	0.00002		
Ethylbenzene	0.02		
Methylene chloride	0.0047		
Tetrachloroethene	2.5		
Toluene	0.05		
Trichloroethene	0.45		
Vinyl chloride	0.005		
Xylenes (Total)	0.0036		
Chlorinated Benzenes			
1,2,4 -Trichlorobenzene	4.9		
1,2 - Dichlorobenzene	0.2		
1,3 - Dichlorobenzene	0.48		
1,4 - Dichlorobenzene	0.48	500	0.0

Table C-4
Calculated Hazard Quotients for the Bald Eagle
(Continued)

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
Chlorobenzene	0.13		
Hexachlorobenzene	49.2	0.2	245.9
PAHs			
2 -Methylnaphthalene	0.76		
Acenaphthene	0.15	20	0.0
Acenaphthylene	0.064		
Anthracene	0.13	20	0.0
Benzo(a)anthracene	0.17	20	0.0
Benzo(a)pyrene	0.033	20	0.0
Benzo(b)fluoranthene	0.043	20	0.0
Benzo(g,h,i) perylene	0.0042	20	0.0
Benzo(k)fluoranthene	0.043	20	0.0
Chrysene	0.23	20	0.0
Fluoranthene	0.17	20	0.0
Fluorene	0.76		
Naphthalene	2.9	20	0.1
Phenanthrene	19.8	20	1.0
Pyrene	0.58	20	0.0
Phenolics			
4 - chloro-3-methylphenol	0.006		
Phenol	0.006		
Phthalate Esters			
Bis(2-ethylhexyl)phthalate	0.3		
Butylbenzylphthalate	0.06		
Di-n-butylphthalate	0.11		

Table C-4
Calculated Hazard Quotients for the Bald Eagle
(Continued)

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
Di-n-octylphthalate	0.7		
Diethylphthalate	0.027		
Other SVOCs			
3,3'-dichlorobenzidine	0.014		
Carbazole	0.004		
Hexachlorobutadiene	774.2	5	154.8
Hexachloroethane	6.4		
N-nitrosodiphenylamine	0.76		
PCBs			
Aroclor-1248	6.8	0.22	30.8
Aroclor-1254	8.3	0.035	238.1
Aroclor-1260	3.9	0.035	111.6
Pesticides			
4,4'-DDD	0.02	0.5	0.0
4,4'-DDE	0.02	0.5	0.0
Aldrin	0.79	2.5	0.3
Alpha-BHC	0.005		
Alpha-chlordane	0.07		
Beta-BHC	0.005		
Delta-BHC	0.003		
Dieldrin	0.0004	0.035	0.0
Endosulfan I	0.3		
Endosulfan II	0.03		
Endosulfan sulfate	0.007		
Endrin	0.003	0.075	0.0

Table C-4
Calculated Hazard Quotients for the Bald Eagle
(Continued)

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
Endrin aldehyde	0.02		
Endrin ketone	0.009		
Gamma-BHC (lindane)	0.008		
Gamma-chlordane	0.01		
Heptachlor epoxide	0.2	0.05	4.4
Ethoxychlor	0.09		
Metals			
Aluminum	404		
Arsenic	7	5	1.4
Barium	14	0.66	20.5
Beryllium	0.03		
Cadmium	0.7	0.02	35.8
Chromium	1	0.05	23.9
Cobalt	1		
Copper	13	24.7	0.5
Iron	548		
Lead	16	1.25	12.8
Magnesium	98		
Manganese	21	24	0.9
Mercury	0.04	0.0005	83.8
Nickel	1.6	6	0.3
Potassium	44		
Selenium	0.05	0.5	0.1
Silver	0.1	1.75	0.1
Vanadium	0.9	1.9	0.5

Table C-4
Calculated Hazard Quotients for the Bald Eagle
(Continued)

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
Zinc	23	14	1.6
Hazard Index			969.4

Table C-5
Calculated Hazard Quotients for the Mink

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
Volatile Organic Analytes			
1,1,1 - Trichloroethane	0.00007	75	0.0
1,1,2,2, Tetrachloroethane	0.8	6.2	0.1
1,1,2 - Trichloroethane	0.1	3.9	0.0
1,1 - Dichloroethane	0.0009		
1,2 - Dichloroethane	0.06		
1,2 - Dichloroethene (Total)	0.03	251	0.0
1,2 - Dichloropropane	0.07		
2-Butanone	0.006	1771	0.0
Acetone	0.3	100	0.0
Benzene	0.005	1	0.0
Carbon disulfide	0.03	1	0.0
Chloroform	0.00005	1.29	0.0
Ethylbenzene	0.04	136	0.0
Methylene chloride	0.01	5.26	0.0
Tetrachloroethene	5	7.1	0.7
Toluene	0.1	590	0.0
Trichloroethene	0.9	100	0.0
Vinyl chloride	0.01		
Xylenes (Total)	0.007	179	0.0
Chlorinated Benzenes			
1,2,4 -Trichlorobenzene	11.4	25	0.5
1,2 - Dichlorobenzene	0.5	125	0.0
1,3 - Dichlorobenzene	1.1		
1,4 - Dichlorobenzene	1.1	40	0.0
Chlorobenzene	0.3	60	0.0
Hexachlorobenzene	111.7	0.08	1396.3

Table C-5
Calculated Hazard Quotients for the Mink
(Continued)

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
PAHs			
2 -Methylnaphthalene	1.8	16.4	0.1
Acenaphthene	0.3	175	0.0
Acenaphthylene	0.1		
Anthracene	0.3	1000	0.0
Benzo(a)anthracene	0.4	10	0.0
Benzo(a)pyrene	0.08	10	0.0
Benzo(b)fluoranthene	0.1	10	0.0
Benzo(g,h,i) perylene	0.01	10	0.0
Benzo(k)fluoranthene	0.1	10	0.0
Chrysene	0.5	10	0.1
Fluoranthene	0.4	125	0.0
Fluorene	1.8	125	0.0
Naphthalene	6.8	36	0.2
Phenanthrene	46	10	4.6
Pyrene	1.4	75	0.0
Phenolics			
4 - chloro-3-methylphenol	0.01		
Phenol	0.01	140	0.0
Phthalate Esters			
Bis(2-ethylhexyl)phthalate	0.8	1.9	0.4
Butylbenzylphthalate	0.1	250	0.0
Di-n-butylphthalate	0.3	8	0.0
Di-n-octylphthalate	1.6	30	0.1
Diethylphthalate	0.06	750	0.0
Other SVOCs			

Table C-5
Calculated Hazard Quotients for the Mink
(Continued)

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
3,3'-Dichlorobenzidine	0.03		
Carbazole	0.01	5	0.0
Hexachlorobutadiene	1793.6	3	597.9
Hexachloroethane	14.9	1	14.9
N-nitrosodiphenylamine	1.8	16.5	0.1
PCBs			
Aroclor-1248	15.4		
Aroclor-1254	19	0.0096	1979.2
Aroclor-1260	8.9	0.5	17.8
Pesticides			
4,4'-DDD	0.05	107	0.0
4,4'-DDE	0.06	4.15	0.0
Aldrin	1.8	0.063	28.6
Alpha-BHC	0.01		
Alpha-chlordane	0.2	1	0.2
Beta-BHC	0.01	6	0.0
Delta-BHC	0.006	10	0.0
Dieldrin	0.0008	0.06	0.0
Endosulfan I	0.7	0.18	3.9
Endosulfan II	0.06	0.18	0.3
Endosulfan sulfate	0.02	0.18	0.1
Endrin	0.007	0.075	0.1
Endrin aldehyde	0.04	0.25	0.2
Endrin ketone	0.02	0.25	0.1
Gamma-BHC (lindane)	0.02	0.16	0.1
Gamma-chlordane	0.03	1	0.0

Table C-5
Calculated Hazard Quotients for the Mink
(Continued)

Chemical	Daily Intake (mg/kgBW/d)	TRV	HQ
Heptachlor epoxide	0.5	0.018	27.8
Methoxychlor	0.2	10	0.0
Metals			
Aluminum	820		
Arsenic	14	0.038	368.4
Barium	27	31.5	0.9
Beryllium	0.05	0.95	0.1
Cadmium	1	0.025	40.0
Chromium	2	2.4	0.8
Cobalt	3	1.59	1.9
Copper	21	67	0.3
Iron	1113		
Lead	32	0.032	1000.0
Magnesium	198		
Manganese	43		
Mercury	0.03	0.02	1.5
Nickel	3	0.0055	545.5
Potassium	89		
Selenium	0.03	0.45	0.1
Silver	0.3	10	0.0
Vanadium	2	0.11	18.2
Zinc	42		
Hazard Index			6052.1